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SoundTransit

Bridge and Structures Working Paper

Prepared for

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TABLE OF CONTENTS

1 INTRODUCTION 1-1

2 DESIGN DEVELOPMENT PROCESS 2-1

2.1 CURRENT DEVELOPMENT STATUS 2-1

2.2 BRIDGE DESIGN DEVELOPMENT PROCESS 2-1

2.2.1 Conceptual Bridge Type Selection 2-1

2.2.2 Type, Size, and Location Study 2-1

2.2.3 Bridge Site Data 2-2

2.2.4 Preliminary Bridge Plan 2-2

2.2.5 Final Design 2-2

3 DESIGN CRITERIA 3-1

3.1 STRUCTURAL DESIGN CRITERIA 3-1

3.2 STRUCTURE WIDTHS 3-2

3.3 AESTHETICS 3-3

4 EXISTING STRUCTURES 4-1

4.1 USE OF EXISTING BRIDGES 4-1

4.2 EVERGREEN POINT FLOATING BRIDGE 4-1

4.3 EVERGREEN POINT FLOATING BRIDGE APPROACHES AND PORTAGE BAY BRIDGE .. 4-1

4.4 OTHER BRIDGES 4-1

5 PROPOSED BRIDGE STRUCTURES 5-1

5.1 WIDENING OF EXISTING BRIDGES 5-1

5.2 REPLACEMENT OF EXISTING BRIDGES 5-1

5.3 PROPOSED NEW BRIDGE TYPES 5-1

5.3.1 Superstructures 5-1

5.3.2 Substructures 5-2

5.3.3 Portage Bay Bridge 5-3

5.3.4 Evergreen Point Floating Bridge and Approaches 5-3

5.3.5 Mainline Bridges 5-3

5.3.6 Ramp Structures 5-6

5.3.7 Local Roads over Mainline 5-9

5.3.8 Pedestrian Bridges 5-9

5.3.9 Bascule Bridge at Montlake Boulevard 5-9

5.3.10 Temporary Bridges 5-11

6 LID STRUCTURES **6-1**
6.1 PURPOSE AND LOCATIONS OF LIDS 6-1
6.2 LID STRUCTURES 6-1
6.2.1 Lid Construction Sequence 6-2
6.2.2 Lid at I-5 and SR 520 Interchange 6-2
6.2.3 Lid at SR-520/Delmar Drive Undercrossing 6-2
6.2.4 Lid at SR-520/Montlake Area Undercrossing with Bus Flyer Stop 6-2
6.2.5 Lid at SR-520/76th Avenue NE Undercrossing with Bus Flyer Stop 6-2
6.2.6 Lid at SR-520/84th Avenue NE Undercrossing 6-2
6.2.7 Lid at SR-520/92nd Avenue NE Undercrossing with Bus Flyer Stop 6-2
7 FOUNDATIONS **7-1**
7.1 GEOTECHNICAL CONDITIONS 7-1
7.2 FOUNDATION TYPES 7-1
7.2.1 Foundations on Land 7-1
7.2.2 Foundations in Water 7-2
8 TUNNELS **8-1**
8.1 NEW SOUTHBOUND TO EASTBOUND RAMP TUNNEL AT I-5/SR-520 INTERCHANGE 8-1
8.2 TUNNEL UNDER SHIP CANAL AT MONTLAKE 8-3
8.2.1 Sunken Tube Tunnel Section 8-3
8.2.2 Cut and Cover Approach Tunnels 8-5
8.2.3 Access Ramps 8-5
8.3 MERCER CORRIDOR TO I-5 NORTHBOUND TUNNEL 8-5
9 RETAINING WALLS **9-6**
9.1 WALLS RETAINING EMBANKMENT FILL 9-6
9.1.1 Reinforced Concrete Walls 9-6
9.1.2 Structural Earth Walls 9-7
9.2 WALLS RETAINING CUT SOIL 9-9
9.2.1 Reinforced Concrete Walls 9-9
9.2.2 Soil Nail Walls 9-10
9.2.3 Soldier Pile Walls 9-11
9.2.4 Cylinder Pile Walls 9-12
9.3 TEMPORARY RETAINING WALLS 9-12
9.3.1 Temporary Cut Walls 9-12
9.3.2 Temporary Fill Walls 9-13
9.4 TIEBACK ON EXISTING WALLS 9-13
10 NOISE WALLS **10-1**

11 CONSTRUCTION IN SENSITIVE AREAS 11-1
11.1 WETLANDS AND SHALLOW WATER 11-1
11.2 CONSTRUCTION OVER WATER 11-2
11.3 NOISE SENSITIVE AREAS 11-2
11.4 DEMOLITION OF EXISTING STRUCTURES 11-2
APPENDIX: STRUCTURE LIST A-1

LIST OF FIGURES

Figure 1 Typical Section Shown with WSDOT Prestressed Girders 5-4
Figure 2 Typical Section Shown with WSDOT Prestressed Girders 5-5
Figure 3 Typical Section Shown with WSDOT Prestressed Girders 5-5
Figure 4 Elevation Views: Fixed Pier and Expansion Pier 5-6
Figure 5 Typical Section Shown with Concrete Box Girder 5-7
Figure 6 Typical Section Shown with Steel Box Girder 5-7
Figure 7 Typical Section Shown with Steel Box Girders 5-8
Figure 8 Typical Section Shown with Concrete Box Girder 5-8
Figure 9 Section: Near Pier and Near Mid-Span 5-10
Figure 10 Bridge Elevation View 5-11
Figure 11 Shaft/Foundation in Water 7-3
Figure 12 Pile Foundations in Water 7-4
Figure 13 Step 1: Tunnel Section Construction 8-1
Figure 14 Step 2: Tunnel Section Construction 8-2
Figure 15 Step 3: Tunnel Section Construction 8-2
Figure 16 Cross Section of Completed Tunnel 8-3
Figure 17 Typical Sunken Tube Tunnel Section 8-4
Figure 18 Retaining Walls in Fill: Standard Concrete Wall 9-2
Figure 19 Retaining Walls in Fill: Structural Earth Wall 9-3
Figure 20 Retaining Walls in Cut: Standard Concrete Wall 9-4
Figure 21 Retaining Walls in Cut: Soil Nail Wall 9-5
Figure 22 Retaining Walls in Cut: Soldier Pile Wall 9-6
Figure 23 Noise Barrier on Spread Footing 10-1
Figure 24 Noise Barrier with Traffic Barrier on Spread Footing 10-1
Figure 25 Noise Barrier with Traffic Barrier on Retaining Wall 10-2

ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
ANSI	American National Standards Institute
AWS	American Welding Society
BRT	Bus Rapid Transit
DEIS	Draft Environmental Impact Statement
EB	Eastbound
EIS	Environmental Impact Statement
FHWA	Federal Highway Administration
HAER	Historic American Engineering Record
HOV	High Occupancy Vehicle
LRFD	Load and Resistance Factor Design
MCEER	Multidisciplinary Center for Earthquake Engineering Research
MSE	Mechanically Stabilized Soil
MOHAI	Museum of History and Industry
NB	Northbound
SB	Southbound
SHPO	State Historic Preservation Officer
TSL	Type, Size, and Location (Study)
WB	Westbound
WSDOT	Washington State Department of Transportation

1 INTRODUCTION

The purpose of this working paper is to describe the structures that are part of the various alternatives proposed for the Trans-Lake Washington Project (the Project). The Project is located in the SR-520 corridor, from the I-5 interchange at the west end of the alignment to the SR-202 interchange at the east end, and includes the Mercer Corridor connection at I-5.

The following four design alternatives were identified during the study for the Draft Environmental Impact Statement (DEIS):

- No-Action Alternative
- Alternative 2: Safety and Preservation, four lanes total
- Alternative 3: Three traffic lanes each direction along mainlines, six lanes total
- Alternative 4: Four traffic lanes each direction along mainlines, eight lanes total

~~Most of~~ the structures described in this working paper apply to Alternatives 2, 3, and 4. The layout of these structures is shown on a separate set of alignment plans. For Alternatives 3 and 4, most existing bridges would need to be replaced or modified. For Alternative 2, a significant number of existing bridges would be utilized, either as they are or with modifications.

These designs are currently at a conceptual level. The primary purpose is to identify feasible structure types and layouts to serve as the basis for determining environmental impacts and costs.

In addition to the mainline structures and local streets that cross over the mainline, the following key areas along this alignment involve multiple structures or lidded roadway sections:

- Northbound on-ramp at the Mercer corridor
- SR-520/I-5 interchange
- SR-520 at the Montlake area
- SR-520/Bellevue Way interchange
- SR-520/SR-405 interchange
- SR-520/SR-202 interchange

In this working paper, the words "lid" or "lidded roadway" refer to structures that are built over the roadway and use the roadway's air rights. In contrast, a "roadway tunnel" is an enclosed roadway for motor vehicle traffic that crosses under a roadway or waterway.

For the tunnel and lid structures in the project, a working paper entitled *Ventilation and Life Safety* (August 16, 2002) has been prepared to address special considerations for enclosed roadway sections.

A technical memorandum entitled *Final Geotechnical Literature Review and Recommendation* (April 11, 2002) identifies the geotechnical conditions along the SR-520 corridor.

WSDOT has studied the replacement of the existing Evergreen Point Floating Bridge and its approach spans, they are not covered in this working paper.

2 DESIGN DEVELOPMENT PROCESS

2.1 CURRENT DEVELOPMENT STATUS

Because the Trans-Lake Washington Project is currently in the early development stage, this working paper focuses on general concepts for structures. To validate the alignments, this conceptual level of development allows for identification of feasible structure types and general layouts. The bridges and structures have been evaluated for general feasibility and constructability, and this analysis will serve as a basis for determining environmental impacts and costs. Further investigation will be necessary to continue developing the structural concepts and to determine the bridge types, member sizes, and final layout.

Common procedures for future bridge design development studies are explained in this section. A similar process will be used for other structures, including lids, tunnels and major retaining walls.

2.2 BRIDGE DESIGN DEVELOPMENT PROCESS

2.2.1 Conceptual Bridge Type Selection

No specific bridge types have been selected as part of this study. The structural investigation has focused on defining viable bridge options. The alignment and interchange configurations have been reviewed, with the goal of determining whether piers and abutments can be placed so that the resulting span length falls within reasonable limits. These general structural layouts have been incorporated in the plan sets for Alternatives 2, 3, and 4, and a list of the structures is included in the Appendix.

In order to maintain flexibility in refining the alternatives, specific material selection (concrete or steel) has not yet been made. As the design process progresses, structural designs will be developed following the process described below.

During the Environmental Impact Statement (EIS) process it may become necessary to provide more specific data on individual structures and to develop the structures further or narrow available options. The EIS process may also specify certain construction methods.

2.2.2 Type, Size, and Location Study

Section 3.3 discusses the need and process for an overall aesthetics plan. This aesthetics plan should be developed either prior to or in conjunction with the Type Size and Location Study.

A Type, Size, and Location (TSL) Study will be prepared for all significant structures, typically after the preferred alignment alternative has been selected. A TSL Study will investigate various layout and bridge-type options. The options will be evaluated and compared in order to determine the preferred structure. For a complex interchange or major structure, the TSL Study will provide a detailed evaluation of multiple options in configuration, span layout, construction staging, materials, construction methods, and costs. For a mid-size structure or a structure of moderate complexity, the TSL Study will be a simple comparison of two or three options. For simple structures, the TSL Study may not be necessary. In critical areas, a preliminary geotechnical and/or hydraulic study should be prepared for use in the TSL Study.

Though some assumptions have been made as to feasible bridge types and layouts, this early conceptual study does not eliminate the need for the TSL study.

2.2.3 Bridge Site Data

After a preferred alternative is selected, the alignment and profile must be verified and approved; then a Bridge Site Data Plan can be prepared. This plan will define the alignment, topography, existing structures, utilities, and other features that need to be considered in the bridge design.

2.2.4 Preliminary Bridge Plan

Based on the approved alignment, the Bridge Site Data and the preferred bridge type of the TSL, a Preliminary Bridge Plan will be developed for each individual structure. Each abutment and pier will be located, the framing of the superstructure will be determined, and the clearances verified. The size of and materials needed for the major structural elements will be determined and design details, such as corrosion protection, barrier types, architectural treatments, utilities, illumination, embankment grading, etc., will be defined. In short, the Preliminary Bridge Plan will define the structure, with the exception of final detailing and final foundation selection. The Preliminary Bridge Plan will be submitted to the state bridge engineer for approval.

As part of the Preliminary Bridge Plan, a geotechnical exploration and testing program will be initiated to produce geotechnical data and recommendations to be used in designing the foundations during the final design stage.

2.2.5 Final Design

The final design will be based on the approved Preliminary Plan. Detailed design calculations and plans are prepared as part of the PS&E package, consisting of Plans, Specifications and Estimate. This package is the basis for the contractor's bid and for construction.

3 DESIGN CRITERIA

3.1 STRUCTURAL DESIGN CRITERIA

For conceptual-level structural layouts, specific structural design criteria do not need to be defined in detail. During the Preliminary Bridge Plan preparation, the state bridge engineer will establish and/or approve final design criteria.

For the design of new structures, the use of the following criteria, guidelines, and specifications are anticipated:

- Washington State Department of Transportation (WSDOT) Design Manual
- WSDOT Bridge Design Manual (Volumes 1 and 2)
- American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) Bridge Design Specifications
- AASHTO LRFD Movable Highway Bridge Design Specifications
- AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals
- American National Standards Institute (ANSI)/AASHTO/American Welding Society (AWS) Bridge Welding Code
- Applicable AASHTO Guide Specifications, for example:
  - Guide Specifications for Horizontally Curved Girder Bridges
  - Guide Specifications for Design of Pedestrian Bridges
  - Guide Specifications for Structural Design of Sound Barriers
  - Guide Specifications for Bridge Temporary Works
- Multidisciplinary Center for Earthquake Engineering Research (MCEER) Recommended Guidelines for the Seismic Design of Highway Bridges (These guidelines have not been adopted by AASHTO or WSDOT, but they represent the latest developments in seismic design and WSDOT uses them for major projects)
- WSDOT Standard Specifications for Road Bridge and Municipal Construction

The geotechnical engineering design criteria will be based on site-specific investigations that will supplement the recommendations made in the geotechnical memorandum entitled *Final Geotechnical Literature Review and Recommendation* (April 11, 2002).

Lid structures are assumed to have a fill depth of no more than 3 feet of soil for landscaping.

Design specifications that are somewhat less stringent may be adopted for the existing structures (listed in the Appendix) that would be incorporated into the Project, if approved by the WSDOT bridge engineer. These changes would be justified when the anticipated remaining service life is less than the typical 75 years expected from new structures.

3.2 STRUCTURE WIDTHS

The proposed typical (minimum) widths for the main-line structures are:

	Four Lanes (Alternative 2)	Six Lanes (Alternative 3)	Eight Lanes (Alternative 4)
Right shoulder	10'-0"	10'-0"	10'-0"
General traffic lanes	2 x12'-0"	2 x12'-0"	3 x 12'-0"
Buffer		4'-0"	4'-0"
BRT / HOV lane	12'-0"	12'-0"	12'-0"
Left shoulder	4'-0"	10'-0"	10'-0"
EB curb-to-curb width	38'-0"	60'-0"	72'-0"
Median barrier	2'-0"	2'-0"	2'-0"
WB curb-to-curb width	38'-0"	60'-0"	72'-0"
Total between outer curbs	78'-0"	122'-0"	146'-0"

The proposed typical (minimum) widths of the ramp structures are:

	Single Lane	Two Lanes
Right shoulder	8'-0"	8'-0"
Lanes	15'-0"	13'-0" 12'-0"
Left shoulder	4'-0"	6'-0"
Total curb-to-curb width	27'-0"	39'-0"

Additional width will be required for acceleration and deceleration lanes. Shoulder widening may be required in curves to provide adequate sight-distance.

3.3 AESTHETICS

Although cost is probably the most significant factor in selecting structure types, aesthetic considerations are also important. Aesthetically pleasing bridges, walls, and tunnels need not cost significantly more than utilitarian structures. Transportation structures are highly visible, and given their typical lifespan of between 50 and 100 years, the public will use and appreciate them for several generations.

For a project of this size, it is important to establish a visual plan and provide a consistent aesthetic theme for the SR-520 corridor after the preferred alternative is selected. This is particularly important for the structures that are visible from the SR-520 corridor, because they are viewed in succession. The visual character of bridges over local streets, retaining walls, and noise walls adjacent to local streets should be tailored to the local condition or neighborhood, because they are visible to local traffic and from adjacent residences.

Good examples of consistent aesthetic treatment are the I-90 corridor across Mercer Island and I-5 through Olympia.

An aesthetics study requires close coordination between an architect experienced in transportation structures and the bridge engineer. It needs to balance aesthetics and technical requirements with cost and define the following:

- Preferred configurations of piers and abutments
- Superstructure types applicable to various locations
- Architectural treatment of wall and abutment faces
- Architectural treatment of traffic barriers and railings
- Types of and architectural treatment for noise barriers
- Sign structure configurations
- Tunnel and lid portal configurations
- Interior finishes of tunnels and lids
- Flyer stop layout, access, and finishes
- Auxiliary structures, such as ventilation structures and emergency exits
- Colors and textures of structural elements

This aesthetics study should be prepared as soon as a preferred alternative is selected, ideally just prior to or together with the TSL studies (see Section 2.2.2).

4 EXISTING STRUCTURES

The Trans-Lake Washington Project could affect approximately 50 existing bridges in the SR-520 corridor and several bridges at the SR-520/I-5 connection. These bridges are listed in the Appendix at the end of this working paper.

4.1 USE OF EXISTING BRIDGES

In Alternative 2, which does not add additional lanes, a significant number of existing bridges could be incorporated into the proposed facility. If work is required at or near a bridge, any bridge maintenance or upgrade work needed should be accomplished at the same time. The existing bridge structures may need the following types of major maintenance: seismic retrofit, deck overlay, barrier or joint replacement, and various repairs.

4.2 EVERGREEN POINT FLOATING BRIDGE

The Project would most significantly affect the Albert D. Rosselini Bridge (better known as the Evergreen Point Floating Bridge). This bridge was constructed approximately 40 years ago. Bridges are generally expected to have a lifespan of about 75 years. A WSDOT review panel has determined that the floating portion of the Evergreen Point Bridge has an estimated remaining life expectancy of 20 to 25 years and that no feasible actions would extend the life of the bridge. An important goal of the Project is to replace the Evergreen Point Bridge before earthquakes or storms further compromise its structural integrity.

4.3 EVERGREEN POINT FLOATING BRIDGE APPROACHES AND PORTAGE BAY BRIDGE

The approach structures to the Evergreen Point Floating Bridge and the Portage Bay bridges are also significant structures. Their superstructures are precast prestressed concrete girders with cast-in-place concrete decks, supported by multi-column pier bents. The columns consist of hollow precast prestressed concrete piles with a diameter of 4.5 feet and a wall thickness of 5 inches. These piers are vulnerable to major seismic events and have very little ductility because reinforcing steel does not confine the concrete of the piles. A seismic retrofit of these bridges would be difficult and expensive, so the prudent course of action would be to replace these structures.

4.4 OTHER BRIDGES

There are a variety of other bridge types in the SR-520 corridor, consisting of structures that are generally not as vulnerable to earthquakes as the hollow columns described above. Depending on the roadway configuration of the alternatives, these bridges will be evaluated on a case-by-case basis to determine if they can be incorporated into the Project (either in their current configuration or with modifications).

5 PROPOSED BRIDGE STRUCTURES

5.1 WIDENING OF EXISTING BRIDGES

In Alternatives 3 and 4, the project team proposes adding lanes to SR-520. Where the roadway alignment and profile match existing bridges, the project team proposes widening the existing bridges to accommodate additional roadway width. A bridge widening is usually accomplished by using the same type of superstructure and extending the piers. It is WSDOT's standard practice to accomplish seismic upgrades and other necessary major maintenance when a bridge is widened.

5.2 REPLACEMENT OF EXISTING BRIDGES

As mentioned previously, the project team proposes replacing the Evergreen Point Floating Bridge, its approaches, and the Portage Bay Bridge for a number of reasons: 1) The bridge alignments do not fit the proposed alignments, 2) the width of the bridges are substandard to the proposed design sections, and 3) the existing structures are vulnerable to storms and/or earthquakes, and upgrading these bridges would not be cost-effective.

At other locations, bridge replacement would be required because the new alignments do not allow incorporation of the existing structures. This is especially true for ramp structures in new interchange configurations. The bridge types proposed for these replacement structures are described in Section 5.3.

5.3 PROPOSED NEW BRIDGE TYPES

This section generally describes the bridge types suitable for the various locations and conditions along the SR-520 corridor. The bridge type selection process is described in Section 2, and aesthetics are discussed in Section 3.

5.3.1 Superstructures

5.3.1.1 Construction Considerations

Traffic in the existing SR-520 corridor must be maintained during construction. Therefore, structure types that can be constructed rapidly using minimal construction space are preferable. Precast prestressed concrete girders and steel girders are prefabricated elements that conform to these requirements. In the Puget Sound area, precast concrete is generally less expensive than steel and is therefore a frequently used bridge type. WSDOT has developed standard precast girder types suitable for a wide range of span lengths. Length limitation is generally set by the weight for transportation and handling and ranges up to 170 feet for highway loading. By splicing girders onsite, spans up to 250 feet can be achieved. Special shapes can be considered when large quantities of girders are involved.

5.3.1.2 Geometric Considerations

Precast girders are not well suited for the curved ramp structures along this corridor. Steel-plate or steel-box girders are the preferred alternative. Steel spans are suitable for construction over traffic, because they can be installed with only short traffic closures. Cast-in-place concrete box girders can also be used where falsework does not interfere with traffic flow.

Precast segmental structures would also have the advantage of rapid construction; however, WSDOT does not favor this bridge type because of concerns related to its seismic performance. Therefore, precast segmental construction should only be given serious consideration with prior approval by the state bridge engineer. Segmental cast-in-place construction would be feasible but relatively time-consuming.

5.3.2 Substructures

Foundations and geotechnical conditions are discussed in Section 7.

5.3.2.1 Abutments

Two primary types of abutments are used on WSDOT bridges.

5.3.2.1.1 Full Height Abutments

If an abutment is located near the lower roadway, a full-height abutment is required. These are wall-type structures that retain earth and are flanked by wingwalls that can be placed parallel to the lower or upper roadway or at an angle. To find the most appropriate configuration for each location, the arrangement must be evaluated at the time of preliminary plan preparation.

5.3.2.1.2 Stub Abutments

If the right-of-way allows, the abutment is often placed farther away from the lower roadway, on top of the embankment slope. This visually opens the roadway to a wider view and feels less confining. This type of stub abutment is similar in cost to the full-height abutment. The added cost of the longer superstructure is balanced by the reduced cost of the abutment and wingwalls.

There is usually an expansion joint at the stub abutment to allow for temperature movements. For short bridges with 150-foot or smaller spans, the expansion joint may be omitted if the design considers the added stresses due to temperature changes. Twenty-five-foot-long reinforced concrete approach slabs are placed at the abutments. The approach slab equalizes potential settlements between the bridge and the adjacent embankment.

5.3.2.2 Piers

Multi-circular-shaped column piers exhibit substantial ductility and are preferred for their good seismic performance. Single-lane ramp bridges are customarily designed for single-column piers with either circular or oblong-shaped columns. In special circumstances, single columns may be used for 2-lane bridges.

Wall-type piers may be used where it is essential to minimize the width required for support between roadways.

In areas where geometric constraints prevent placement of columns directly under the superstructure, piers with straddle bents or cantilever bents would need to be constructed. Every effort should be made to avoid these conditions, because the seismic performance of these irregular pier types is less predictable than regularly located columns, and they require much heavier reinforcing. Prestressing is often needed to provide adequate strength. In addition, these straddle piers are not visually attractive.

5.3.3 Portage Bay Bridge

Structures over water are constructed with long spans and wide column spacing, because fewer in-water columns result in less environmental impacts. As pointed out previously, the practical span limit for precast concrete girders is 250 feet. The girders for these spans could be delivered to the Project site by barge in one piece or by land in sections, then post tensioned together. Where possible, these long spans have been indicated on the plans. The drawback with long spans is that the depth of the structure is larger than it is for short spans, potentially increasing shadow intensity on the water.

For wide structures, the project team proposes that column spacing along the centerline of the piers be in the range of 20 to 40 feet, with specific spacing depending on the framing layout and total structure width. Columns would be about 6 to 8 feet in diameter for bridges over water in the Portage Bay area. Construction staging might make additional columns necessary to ensure that the partial structures are stable.

5.3.4 Evergreen Point Floating Bridge and Approaches

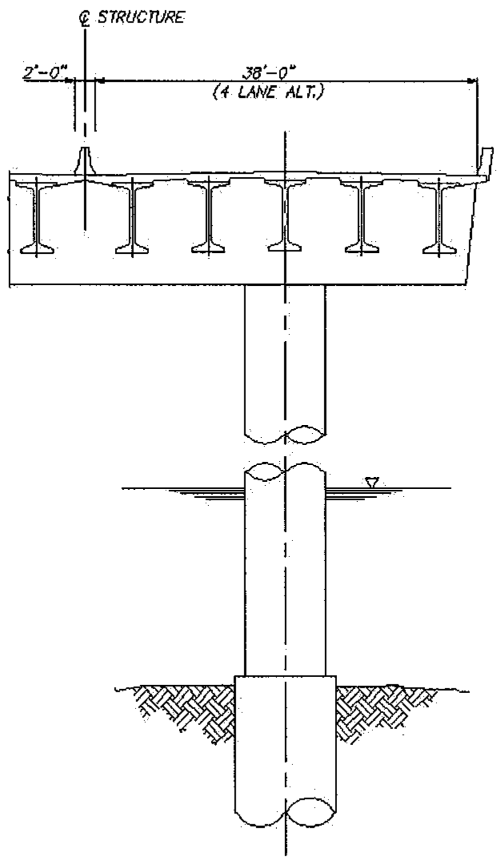
The WSDOT Bridge and Structure Office will provide a separate description of this structure.

5.3.5 Mainline Bridges

The existing mainline structures that carry SR-520 over local streets or over water need to be either replaced or widened in many locations. The most likely structural type for these bridges would be precast prestressed concrete girders supported by concrete pier caps and multi-column piers. (See Figures 1 through 4.) These bridges offer the advantage of being relatively easy to construct in stages, which is important for maintaining traffic flow during construction.

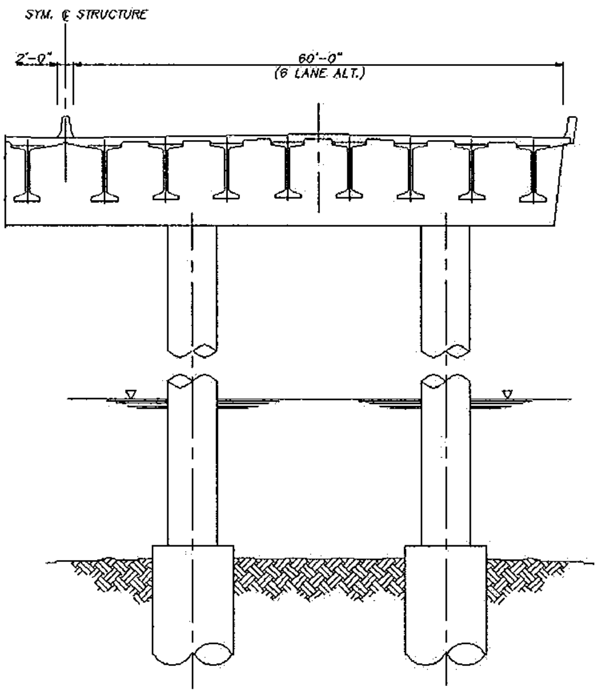
As discussed previously, the over-water spans would be as long as practical to minimize the number of columns in the water. In order to install long spans that must be spliced and post-tensioned together on site, additional temporary supports would be required.

For mainline structures over local roads, clearance requirements would dictate span lengths. Columns in the center of the roadway would be avoided where possible. Embankments sloped back to stub-abutments would be preferred to provide more open views. Where space does not allow the embankment to be sloped back, a full-height abutment near the lower road would be utilized.



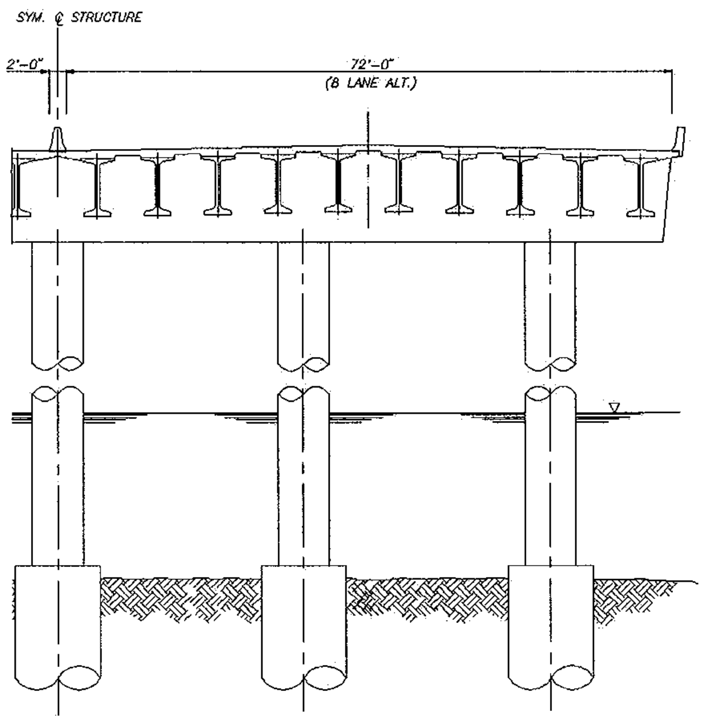
TYPICAL SECTION
SHOWN WITH WSDOT PRESTRESSED GIRDERS

Figure 1



TYPICAL SECTION
SHOWN WITH WSDOT PRESTRESSED GIRDERS

Figure 2



TYPICAL SECTION
SHOWN WITH WSDOT PRESTRESSED GIRDERS

Figure 3

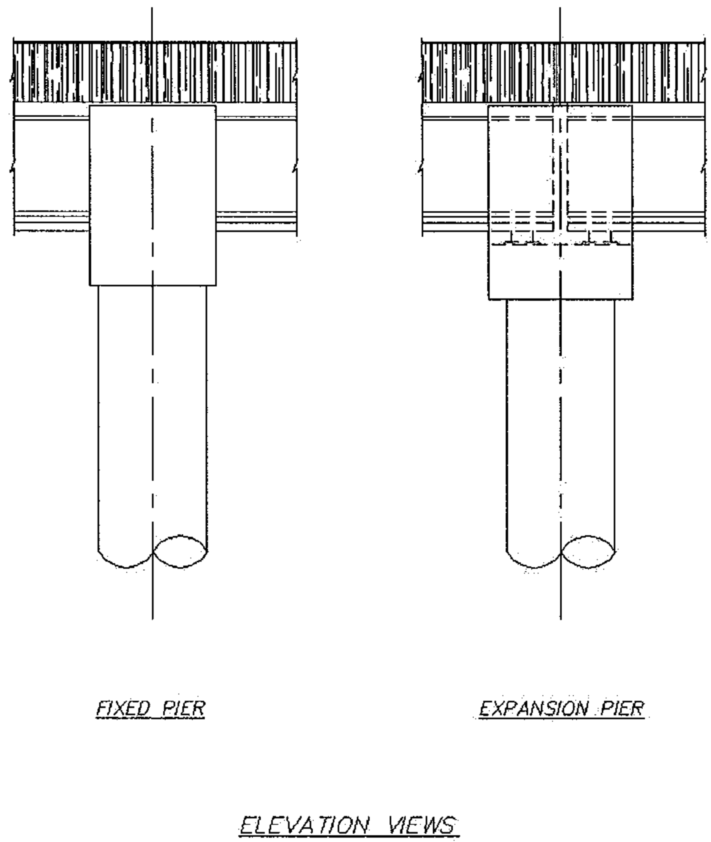


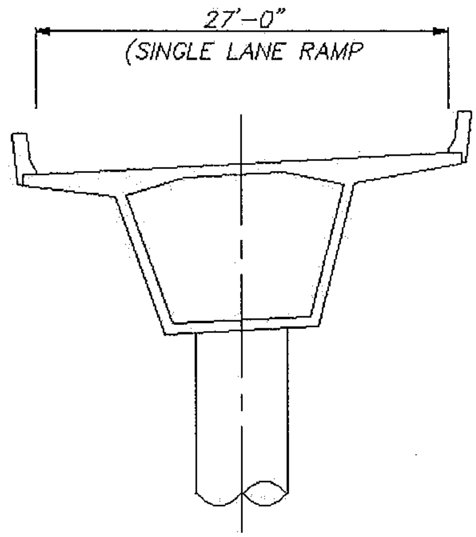
Figure 4

5.3.6 Ramp Structures

Most of the ramp structures in the SR-520 corridor are curved, and many will need to be constructed over traffic. The most likely bridge type for curved ramps would therefore be a box girder structure. Steel box girders are preferred when construction speed is an important consideration. (See Figures 5 through 8.)

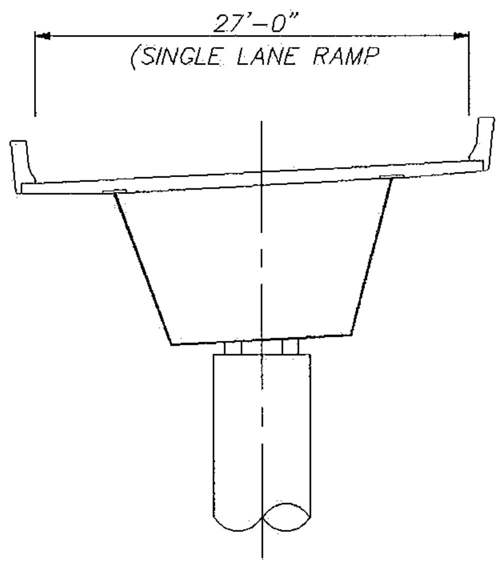
The span length of the ramps depends on the layout of the surface roads over which they cross. Span lengths are generally in the 100- to 200-foot range. Spans more than 250 feet should be avoided, because they require more structural depth, look bulky, and require steeper or longer ramps due to structure depth.

For single-lane ramps, single-column piers are proposed. For wider ramps, two-column piers may be required. In locations where lower roads prevent placing columns directly under ramps, straddle bents would need to be considered. However, due to seismic design considerations, these bents get to be bulky and cannot easily be made to look graceful, so they should be avoided if at all possible by adjusting the alignment.



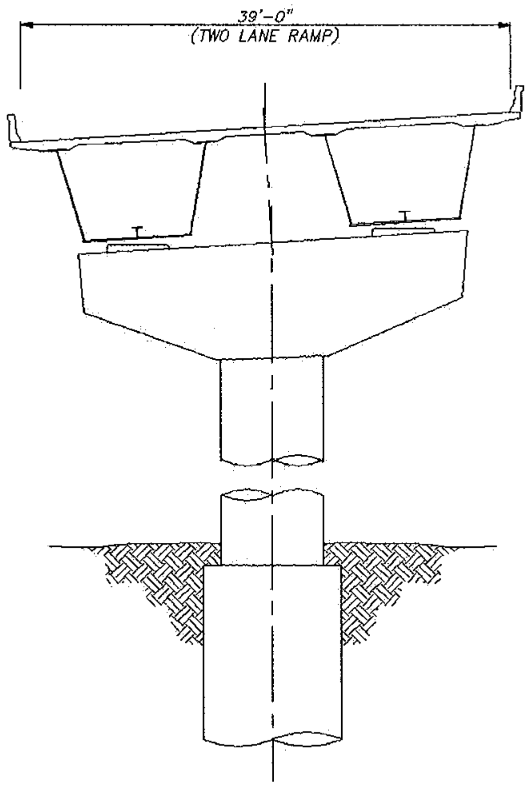
TYPICAL SECTION
SHOWN WITH CONCRETE BOX GIRDER

Figure 5



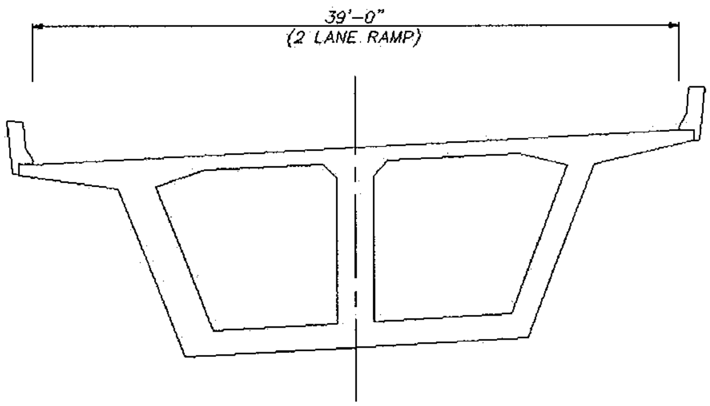
TYPICAL SECTION
SHOWN WITH STEEL BOX GIRDER

Figure 6



TYPICAL SECTION
SHOWN WITH STEEL BOX GIRDERS

Figure 7



TYPICAL SECTION
SHOWN WITH CONCRETE BOX GIRDER

Figure 8

5.3.7 Local Roads over Mainline

The local roadways that cross over SR-520 would generally have a support in the median of SR-520 to reduce the spans to a manageable size. Additional piers would be placed outside of the roadway. The preferred pier supports would be multi-column or wall type. Stub abutments with a sloped back embankment are proposed. Right-of-way and other constraints often require use of full-height abutments, particularly for the 8-lane alternative (Alternative 4).

Bridge types need to be compatible with the ramp structures, because all bridges cross over the mainline. This means that if box girders were selected for the ramps, box girders would be preferred for bridges that carry local roads over the mainline.

5.3.8 Pedestrian Bridges

Pedestrian bridges are very similar to ramp bridges. Because they are narrower, the span length should be moderate in order to achieve a balanced depth-to-width ratio for the structure.

Pedestrian bridges that cross the mainline should have a minimum 10-foot-high protective fence that turns inwards at the top. The use of protective fences should also be considered where pedestrian bridges cross over local streets that have heavy traffic volumes.

5.3.9 Bascule Bridge at Montlake Boulevard

5.3.9.1 Existing Montlake Bascule Bridge

The existing Montlake Bascule Bridge was constructed in 1916 and listed in the National Register of Historic Places on July 16, 1982.

This is a trunnion type bascule bridge, with truss girders and a span length of 182 feet from trunnion to trunnion, providing a horizontal clearance of 150 feet. The superstructure has a roadway width of 40 feet for two traffic lanes in each direction, and a 10-foot sidewalk on both sides. An overhead wire system for trolley buses is also provided.

The bridge's mechanical and electrical systems were refurbished and the structure was seismically retrofitted in the late 1990s.

For Alternatives 3 and 4, the existing Montlake Bascule Bridge cannot accommodate the increased traffic demand across the Ship Canal. The addition of a new parallel bascule bridge is proposed to provide added capacity for Alternative 3. A separate tunnel is proposed for Alternative 4, and no modification of the existing bascule bridge would be required.

5.3.9.2 New 3-Lane Bascule Bridge

To supplement the existing bascule bridge, a new 3-lane bascule bridge would be constructed parallel to and east of the existing bridge.

To provide sufficient space between the new bascule pier and the existing control tower, the clearance between the new bridge and the existing deck would be about 30 feet.

The new bridge would carry three northbound lanes, a bike lane, and a sidewalk. After its completion, all traffic would be temporarily diverted to the new bridge. The existing bridge would then be reconfigured to carry three southbound lanes, a bike lane, and a sidewalk.

For this new bridge, the project team proposes placing the face of the new bascule piers behind the sidewalks that run along the Ship Canal. This would allow construction of the new piers behind the armored slope of the canal. The span length would be about 25 to 30 feet longer than the existing bridge. Bridge deck elevation and navigation clearances would remain the same. Figures 9 and 10 show possible section and elevation views of this proposed new bascule bridge. No bridge studies beyond basic span layout have been performed.

The new bascule bridge type would be similar to the existing bridge. The bridge girders could be welded plate girders or truss girders. The piers would be relatively large box structures, to contain the counterweight.

In order to arrive at a design that would be acceptable to the community, the development of specific bridge details and aesthetics will require an intensive public involvement process.

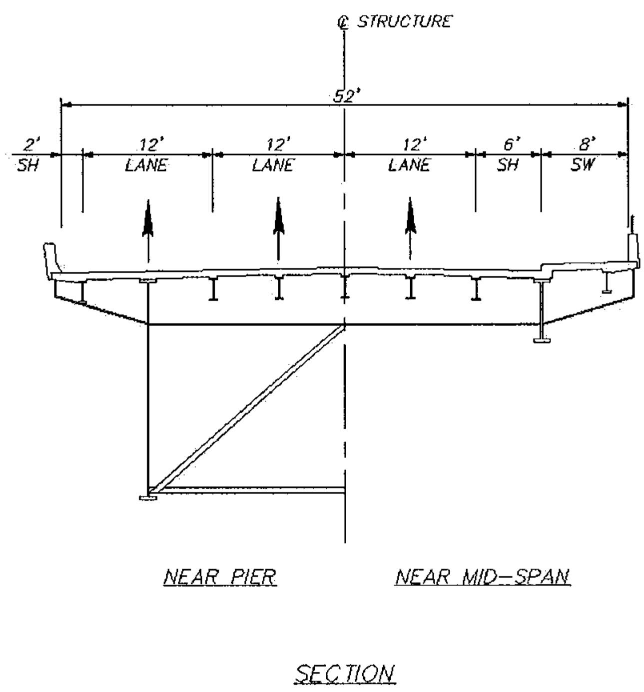
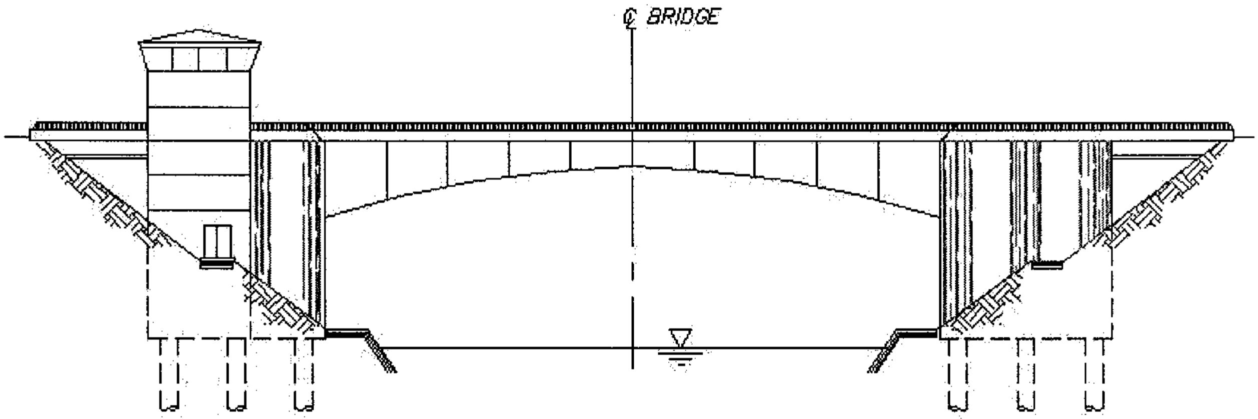


Figure 9



ELEVATION
Figure 10

5.3.9.3 Historic Preservation Issues

The existing Montlake Bascule Bridge was listed in the National Register of Historic Places on July 16, 1982. The following preliminary analysis is based on limited information.

Construction of a new bridge adjacent to the existing Montlake Bridge could constitute an “adverse effect,” because the new bridge could degrade or upset the existing historic bridge’s setting. Mitigation of adverse effects on historic properties would be negotiated in consultation with the State Historic Preservation Officer (SHPO) of the Office of Archaeology and Historic Preservation in Olympia. Typical mitigation for “adverse impacts” on existing historic bridges that are left in place consists of adhering to standards set by the Historic American Engineering Record (HAER).

If great care is taken to build a "compatible" bridge (developed in close consultation with the SHPO) adjacent to the historic bridge, a finding of "no adverse effect" might be achieved. However, simply duplicating the existing bridge would not be an acceptable solution, and constructing a non-compatible bridge next to the existing bridge would almost certainly not be approved by the SHPO. Attaining the desired outcome of "no adverse effect" would be a challenging task.

Changing the “adverse effect” to “no adverse effect” would be an important factor in the Federal Highway Administration (FHWA)’s review of the Project's Section 4(f) analysis.

5.3.10 Temporary Bridges

During construction, temporary bridges may be required in some locations in the SR-520 corridor. These bridges are generally designed to the same live load capacity as other bridges. If a structure were in place for a short duration, the seismic design requirements could be somewhat relaxed with WSDOT’s approval.

The materials and detailing for temporary bridges can be modified to facilitate erection, removal, and possible reuse. Steel-framed structures and precast concrete elements are easier to erect and remove than cast-in-place concrete structures.

6 LID STRUCTURES

6.1 PURPOSE AND LOCATIONS OF LIDS

The primary purpose of the proposed lid structures is to reconnect the neighborhoods across the SR-520 corridor. A secondary benefit is reducing traffic noise for adjacent properties.

The use of lids can be tailored to the communities they serve. They may be landscaped areas that create a park-like setting for passive recreation or contain activity opportunities (e.g., tennis courts, play fields, bike paths, pedestrian trails).

No lids are included in the 4-lane alternative (Alternative 2). Lids are proposed for the 6- and 8-lane alternatives (Alternatives 3 and 4, respectively), with bus flyer stops incorporated at several lids. The proposed locations are:

- I-5/SR-520 interchange
- SR-520 at Delmar Drive undercrossing
- SR-520 at Montlake Area undercrossing with bus flyer (BRT) stop
- SR-520 at 76th Avenue NE (Evergreen Point Drive) undercrossing with bus flyer (BRT) stop
- SR-520 at 84th Avenue NE undercrossing
- SR-520 at 92nd Avenue NE undercrossing with bus flyer (BRT) stop

To avoid the need for mechanical ventilation, the length of the lids would be limited to 500 feet. There still would be a need to provide ventilation to the flyer stop waiting areas. Ventilation and life safety aspects for lids are covered in a separate memorandum entitled *Ventilation and Life Safety* (July 12, 2002).

6.2 LID STRUCTURES

The proposed lid structures would consist of precast prestressed concrete girders constructed perpendicular to the roadway, with a concrete deck. To separate eastbound and westbound lanes, the proposed spans would have wall-type supports at each side and in the center. Where there are flyer stops, two walls are proposed to separate the flyer stop areas from through lanes. Special finishes, such as wall tiles and ceiling panels, have not been considered in this preliminary phase of the project, however they will need to be incorporated as the lids are further developed.

It is assumed that the amount of soil fill placed on the lids would be limited to 3 feet, in order to limit the loads. Based on the assumed soil loads, the approximate maximum span length of about 130 feet could be accommodated.

6.2.1 Lid Construction Sequence

For safety concerns, the preferred construction sequence would be to avoid constructing lids over active traffic by detouring traffic during construction. However, if a construction detour is not feasible, strict safety procedures would have to be implemented to ensure girder security during construction.

6.2.2 Lid at I-5 and SR 520 Interchange

This proposed lid structure is irregularly shaped. It would cover all I-5 lanes near the existing Roanoke Street Bridge and portions of SR-520 from the interchange to the existing 10th Avenue Bridge. The span lengths would vary from approximately 100 feet to 130 feet.

6.2.3 Lid at SR-520/Delmar Drive Undercrossing

The current layout of this proposed lid shows a 2-span structure. The north span would be approximately 165 feet long. To support 3 feet of soil load, this span would require a deeper than usual girder or additional supports located between the SR-520 westbound lanes and the HOV lanes may be necessary.

6.2.4 Lid at SR-520/Montlake Area Undercrossing with Bus Flyer (BRT) Stop

This proposed lid in the Montlake area covers all eastbound and westbound SR-520 lanes and an eastbound on-ramp. It is expected to be a 3-span structure with the center span over the flyer stop. The maximum span length would be about 130 feet.

6.2.5 Lid at SR-520/76th Avenue NE Undercrossing with Bus Flyer (BRT) Stop

This proposed lid at 76th Avenue (Evergreen Point Drive) would cover all eastbound and westbound SR-520 lanes and a flyer stop. It is expected to be a three-span structure with the center span over the flyer stop. The maximum span length would be about 100 feet.

6.2.6 Lid at SR-520/84th Avenue NE Undercrossing

The proposed lid at 84th Avenue would cover all the eastbound and westbound SR-520 lanes, and the westbound on-ramp. It is expected to be a two-span structure. The north span would be approximately 150 feet long. To support 3 feet of soil load, additional supports located between the SR-520 westbound lane and the westbound on-ramp may be necessary.

6.2.7 Lid at SR-520/92nd Avenue NE Undercrossing with Bus Flyer (BRT) Stop

The proposed lid at 92nd Avenue would cover all eastbound and westbound SR-520 lanes. This lid would be expected to be a 3-span structure with the center span over the flyer stop. The maximum span length would be about 110 feet.

7 FOUNDATIONS

7.1 GEOTECHNICAL CONDITIONS

The geotechnical information collected for the Trans-Lake Washington Project for this early design stage is limited to the data available from previous explorations and construction in the corridor, documented in a memorandum entitled *Final Geotechnical Review and Recommendation* (April 11, 2002). This memorandum provides the information needed for a conceptual-level assessment of the foundation conditions. Additional data on foundations will need to be collected for final design. The geotechnical exploration and testing program will be initiated as part of the preliminary bridge plan preparation and will produce data for use during final foundation design.

7.2 FOUNDATION TYPES

7.2.1 Foundations on Land

Spread footings are used if the soil has sufficient vertical and horizontal bearing capacity and the space can adequately accommodate the required footing size. If space is limited, a drilled shaft can be utilized to take advantage of the increased bearing capacity caused by the adjacent overburden and side friction. This type of shaft foundation may be moderate in depth. To provide for lateral stability and moment capacity for seismic loading, the diameter of the shaft foundation is usually at least 2 to 4 feet larger than the column.

Deep foundations are required where the soil's bearing capacity near the surface cannot adequately support heavy bridge loads. In recent years, the use of drilled shaft foundations has become very common. Shafts require minimum space, can carry very heavy loads, and provide sufficient lateral load capacity for seismic design loads. Shaft construction is relatively quiet, because it avoids the noise impacts of pile driving.

Obstructions (e.g., boulders) can pose a significant problem for shaft drilling. Shafts must be reasonably centered under the columns they support, which doesn't allow the flexibility to relocate a shaft if obstructions are encountered. It is therefore recommended that an exploratory boring be performed at each shaft location.

Other deep foundations consist of driven piles covered by a concrete cap to support the pier column. This foundation type would be easier to install than shafts, if boulders were encountered during soils exploration. Piling installations create significant noise. If possible, pile foundations would be avoided near noise-sensitive areas such as hospitals and residential neighborhoods.

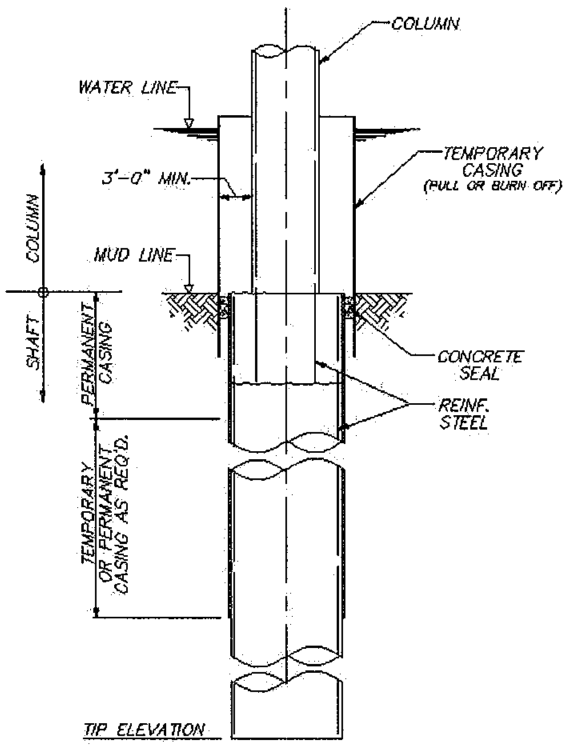
7.2.2 Foundations in Water

In-water foundations are almost always deep and require additional considerations. To achieve high-quality footing and column construction, a dewatering construction pit needs to be provided. Shafts have a steel shell that allows dewatering and column construction in the dry, provided the shaft is sufficiently larger than the column to allow placement of the column-reinforcing steel and forms. (See Figure 11.)

To provide a dry construction pit for a pile cap, it is customary to drive sheet piles to form a cofferdam around the footing, excavate to the bottom level, and then drive the piles. Concrete is then placed under water through a tremie pipe to counteract the uplift by the water pressure. The water can then be pumped out and the foundation and columns constructed in the dry.

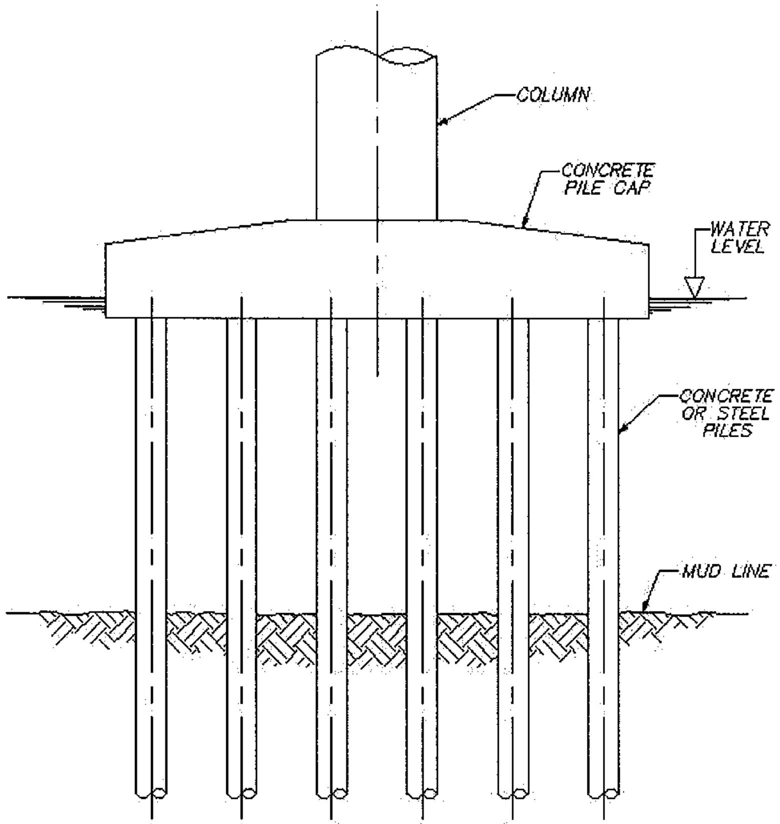
As an alternative, a group of piles can be driven from the surface. A pile cap can be constructed over these piles just at the water level, and then the column can be built on top of the cap. (See Figure 12.)

The selection of a specific foundation type is based on construction feasibility, cost, and environmental impact. Shafts have a practical depth limit of about 150 feet, but piles can be driven 200 feet deep or more. The environmental impact for shafts is less than for foundations on piles. If the pile cap is placed below the mud line, the cofferdam installation and removal will have a larger environmental impact during construction. For a group of piles with a cap at water level, the impact during construction is smaller, but the cluster of piles can cause long-term environmental impacts.



SHAFT/FOUNDATION
IN WATER

Figure 11



PILE FOUNDATION
IN WATER

Figure 12

8 TUNNELS

This section describes the individual tunnels proposed for this project.

8.1 NEW SOUTHBOUND TO EASTBOUND RAMP TUNNEL AT I-5/SR-520 INTERCHANGE

The existing tunnel for traffic exiting the left lane of southbound I-5 passes under the reversible express lanes and northbound I-5 lanes and then surfaces to merge on the left side of eastbound SR-520. The project team proposes to use this tunnel as a reversible HOV lane and construct a new tunnel for general traffic.

The new tunnel would take general-purpose traffic from the outside southbound I-5 lane and pass under the southbound, reversible, and northbound lanes to merge with the outside eastbound SR-520 lanes. This tunnel profile would be kept as high as possible to reduce unnecessary construction cost. Tunnels with small overburden such as these must be constructed from the surface by the cut-and-cover method. It is proposed that the top slab of the tunnel serve as the pavement surface of the I-5 roadways. The curb-to-curb tunnel width would be 27 feet. With an allowance for traffic barriers, the wall-to-wall dimension would be about 30 feet.

Because the I-5 lanes cannot be closed to traffic, this ramp tunnel would have to be constructed in several stages, as described in the memorandum *Draft SR 520 Construction Staging and Corridor Sequencing* (June 14, 2002). Starting at the north end, the tunnel would be constructed in sections, gradually working across the southbound lanes, the express lanes, and the northbound I-5 lanes. Lateral shifting of the traffic lanes would be required to accommodate construction.

To reduce the traffic restriction times on I-5, the following steps are proposed for each section:

Step 1: Close lanes to traffic. Saw-cut and remove pavement. Drill holes and install reinforced concrete shafts to form a tangent pile wall on each side of the tunnel. Excavate to the bottom of the top slab and cast a thin concrete working slab. (See Figure 13.)

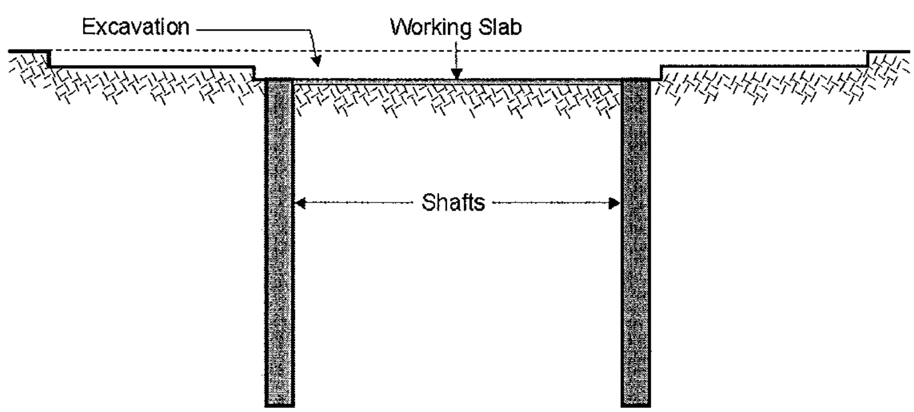


Figure 13
Step 1: Tunnel Section Construction

Step 2: Place reinforcement and cast the top slab directly on the working slab with a bond breaker. Place reinforcement and cast the approach slabs. Cure concrete, install joints, and reopen lanes to traffic. (See Figure 14.)

The above sequence would be repeated in sections until the tunnel walls and top are complete across the southbound lanes, reversible express lanes, and northbound lanes.

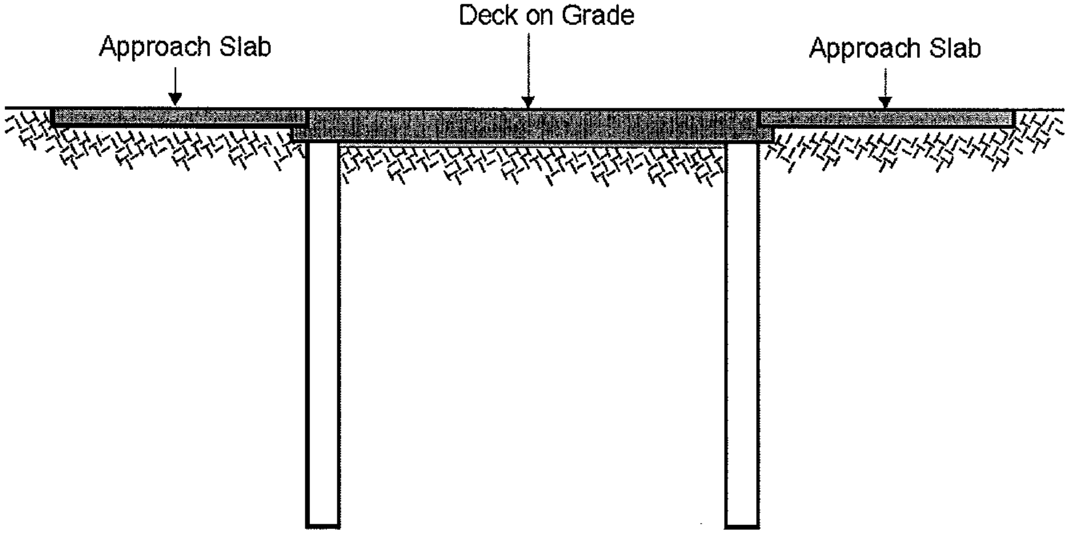


Figure 14
Step 2: Tunnel Section Construction

Step 3: Excavation of the tunnel cavity would now proceed from one end of the tunnel to the other. This would be followed by installation of drainpipes; casting of the bottom roadway slab, walls, and barriers; then installation of traffic and ventilation systems. (See Figure 15.)

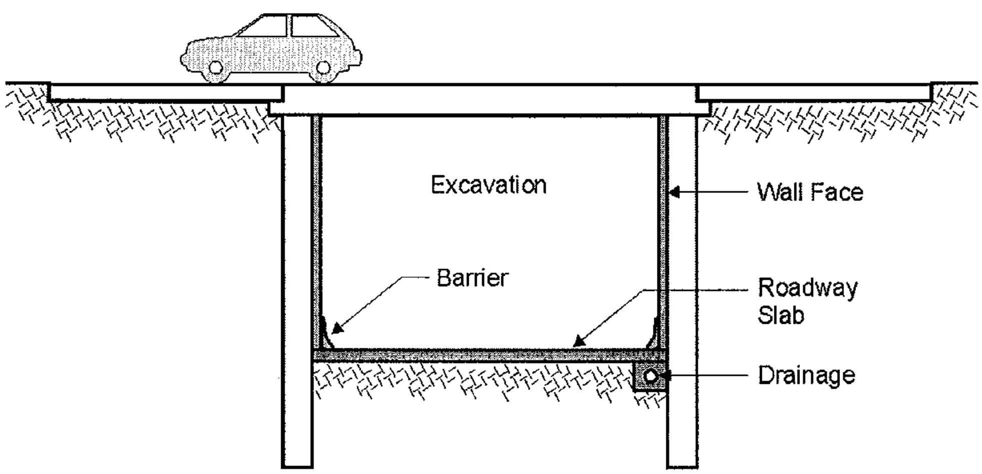


Figure 15
Step 3: Tunnel Section Construction

Figure 16 shows a cross section of the completed tunnel.

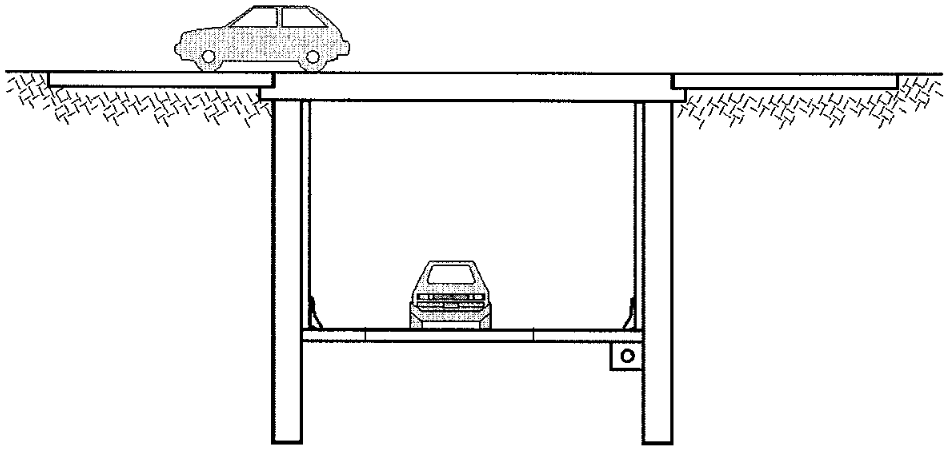


Figure 16
Cross Section of Completed Tunnel

8.2 TUNNEL UNDER SHIP CANAL AT MONTLAKE

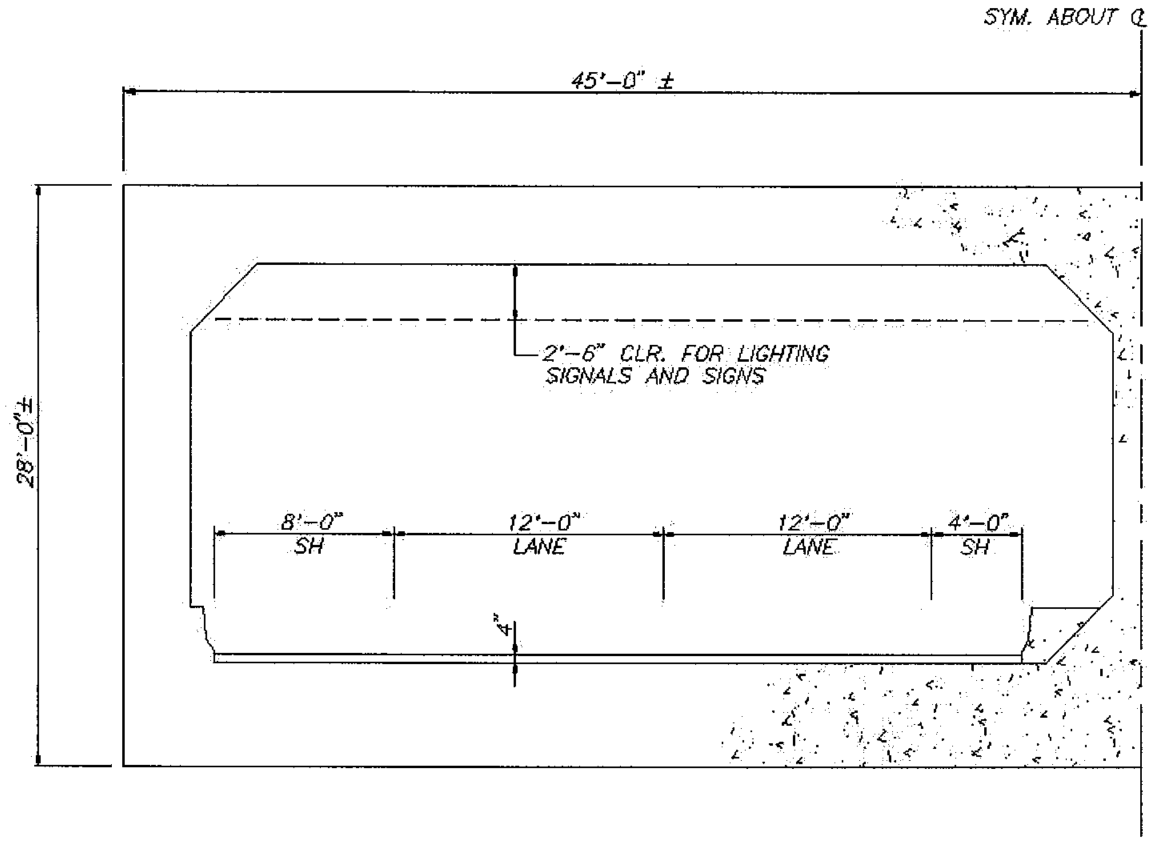
The interchange at Montlake Boulevard is not adequate for the traffic demands of the 8-lane alternative (Alternative 4). Under this alternative, a secondary interchange would be constructed approximately 1,100 feet to the east to accommodate part of the traffic. A new 4-lane connection from this new interchange to the north is proposed as a tunnel under the Ship Canal. The new tunnel would start where the current Museum of History and Industry (MOHAI) parking lot is located. It would descend in a steep grade below the Ship Canal, then rise in a curved alignment toward the intersection of Montlake Boulevard and Pacific Avenue. The new tunnel would form the lower level of the intersection, splitting into new ramps to and from Montlake Boulevard and Pacific Avenue. Tunnel options are described in this section.

The proposed ventilation and fire suppression systems required for this tunnel are described in the technical memorandum *Ventilation and Life Safety* (August 14, 2002).

8.2.1 Sunken Tube Tunnel Section

The centerpiece of this tunnel is the sunken tube section that would cross the Ship Canal in the Montlake area. To keep the approach grades to a reasonable slope, the tunnel crossing the canal should have a minimum cover. However, this cover would not be adequate for safely driving a tunnel bore (either by mining or with a tunnel-boring machine). The remaining option would be to construct the tunnel with open excavation. To avoid cofferdams in the Ship Canal, it is proposed to construct the tunnel box in a graving dock located in the MOHAI parking lot, then float the sections into place and sink them. This sequence is described and illustrated in the memorandum *Draft SR 520 Construction Staging and Corridor Sequencing* (June 14, 2002).

The tunnel box would likely be a reinforced concrete twin cell box, constructed in two sections to limit the required size of the graving dock (See Figure 17). The dimensions of this box structure would be set so that it could float with the minimal freeboard needed to float the structure into place. Double seals would be detailed so that the inner seal could be replaced from inside the tunnel.



TYPICAL SUNKEN TUBE
TUNNEL SECTION

Figure 17

The height of the underwater tunnel section would provide the minimum vertical clearance, with the assumption that the ventilation for this section would be longitudinal and the ducts would start on either side in the adjacent cut-and-cover section.

Excavation to about 30 feet below the bottom of the channel would be accomplished by dredging. It may be necessary to remove the top layer of sediments first if testing shows that they contain contamination. Disposal would depend on the type and concentration of contaminants. Gravel bedding would be placed and graded prior to placing the tunnel sections. The backfill would be with clean gravel, placed with a tremie pipe to minimize dispersal of fine material. During most of these operations, construction barges would take up half the width of the Ship Canal. With advance notice, the barges could be removed to allow passage of large vessels.

8.2.2 Cut and Cover Approach Tunnels

The sections adjacent to the sunken tube would be built by conventional cut-and-cover construction. With this method, an excavation protection wall is constructed and the soil inside is excavated. The protection walls can be soldier piles with timber lagging in areas where water inflow is moderate and can be handled by pumping. If the surrounding ground conditions result in large inflow, a more solid protection wall would be needed, such as a slurry wall or a tangent pile wall. Internal bracing or temporary tiebacks could support either of these wall types. Detailed geotechnical investigations would be needed to determine the best-suited wall type. For the excavation in the MOHAI parking lot (which would serve as a graving dock), a watertight wall system (preferably with tiebacks) would be constructed to provide a dry and open work area.

The reinforced concrete twin-box tunnel structure would be constructed in the open excavation. On both sides of the sunken tube tunnel, the box structure height does not face the same limitations as below the canal, and additional headroom would be provided to accommodate traffic signs. Ventilation duct spaces would be provided on top of the tunnel box, and there would be ventilation structures and emergency egress at selected locations.

8.2.3 Access Ramps

Separate access ramps to this new tunnel would be provided for northbound and southbound traffic at the Montlake Boulevard/Pacific Avenue intersection. From the south portal, side-by-side ramps would connect the interchange with SR-520. Access ramp construction would take place in stages. A portion of the University of Washington's triangle parking garage would have to be removed to provide space for the access ramps.

8.3 MERCER CORRIDOR TO I-5 NORTHBOUND TUNNEL

The current on ramp from the Mercer Corridor merges on the left side with the I-5 northbound lanes. It is proposed to extend the on ramp under the I-5 northbound lanes and under the Lakeview Boulevard off ramp and merge on the right side with I-5 northbound.

This new tunnel would pose some unique challenges. At the west portal it passes under an elevated part of the existing I-5 northbound lanes. Several columns of this existing structure would have to be underpinned to allow this new tunnel to be constructed.

The tunnel would be constructed similar as described in section 8.1. If closure of the lanes were possible, the construction could occur in open cut.

The proposed tunnel would be directly in front of an existing cylinder pile wall. This wall would have to be stabilized with tieback, before any excavation could take place. See section 9.4 for further description.

9 RETAINING WALLS

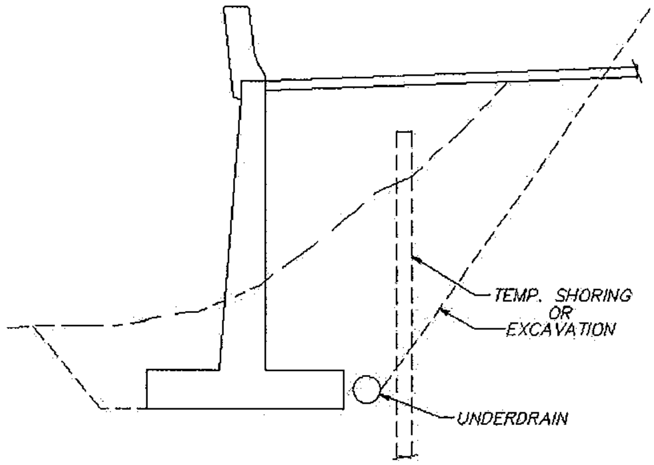
The aesthetics of retaining walls are an important consideration in a corridor traveled by a large number of people. Because the Project runs through sensitive residential areas, the view from outside the corridor is equally important. The recommended permanent wall types recommended include either cast-in-place concrete facing or modular precast concrete panels. These wall types lend themselves to the use of form liners to produce geometric or artistic patterns that create an attractive wall face at moderate extra cost. A pigmented sealer application makes the surface more uniform and makes graffiti paint removal easier.

The retaining walls required for the various Trans-Lake Washington Project alternatives can be grouped into several categories. The specific wall types to be used in each location have not yet been determined. Additional information will be required for wall-type selection, including specific wall heights and detailed geotechnical investigations. Section 1130 of the WSDOT Design Manual includes extensive descriptions of various wall types and discusses their advantages and disadvantages. The following section is limited to the wall types most applicable for the Project. Many variations of these basic wall types may be adapted to specific local conditions during design.

9.1 WALLS RETAINING EMBANKMENT FILL

9.1.1 Reinforced Concrete Walls

Reinforced concrete cantilever walls are the traditional type of retaining wall and can be used from a minimal height to more than 30 feet. (See Figure 18.) Walls between 30 and 50 feet high are usually built as counterfort walls, meaning that there are ribs behind the wall that add strength to the wall system while keeping the typical wall section thin. These walls have a foundation width of about 60 percent of the wall height. They must be founded on competent soil, because they tolerate only small settlement.



STANDARD CONCRETE WALL

RETAINING WALLS IN FILL

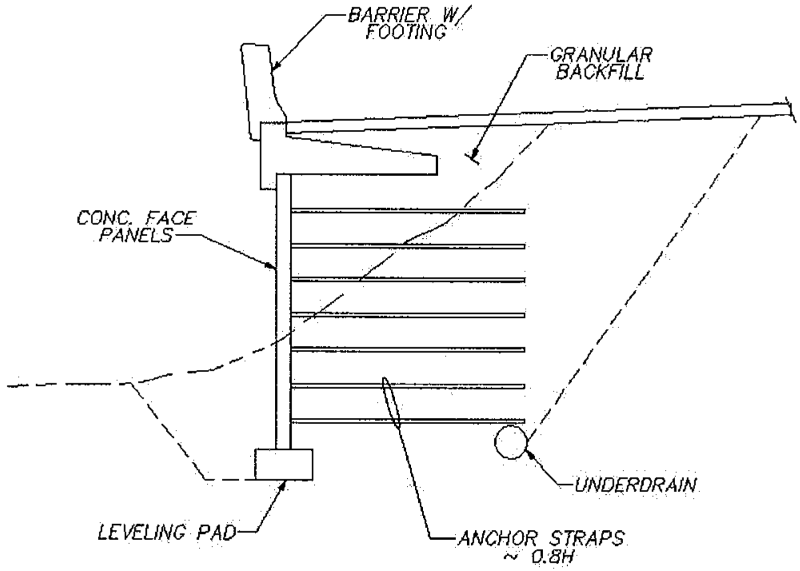
Figure 18

9.1.2 Structural Earth Walls

There are several proprietary Structural Earth (or Mechanically Stabilized Soil [MSE]) Wall systems on the market. They all provide wall stability by placing steel reinforcing (individual straps or wire mesh) between layers of select fill material. (See Figure 19.) This stabilized soil mass provides the wall's stability. Precast concrete panels of varying shapes, anchored to the steel reinforcing, provide a permanent facing and protect the structural fill from erosion.

MSE walls are settlement-tolerant and cost-effective up to a height of more than 40 feet. The required width of the stabilized soil is about 70 percent of wall height.

One drawback to MSE walls is that if a traffic barrier is required on top of the wall, the MSE panel wouldn't be strong enough to resist the potential vehicle impact load and the barrier must have its own shallow footing on top of the backfill. Utilities and right-of-way restrictions may limit the use of MSE walls.



STRUCTURAL EARTH WALL

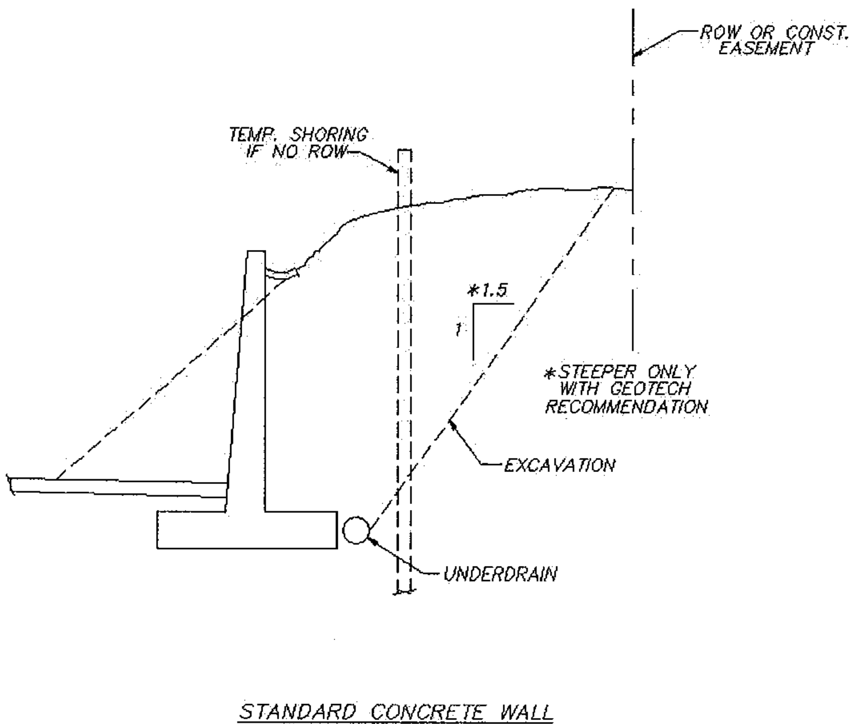
RETAINING WALLS IN FILL

Figure 19

9.2 WALLS RETAINING CUT SOIL

9.2.1 Reinforced Concrete Walls

Reinforced concrete cantilever walls are also applicable to cut conditions. (See Figure 20.) However, excavation must be completed first, followed by wall construction and backfilling behind the wall, often creating problems and perhaps requiring temporary excavation protection when space is restricted.



RETAINING WALLS IN CUT

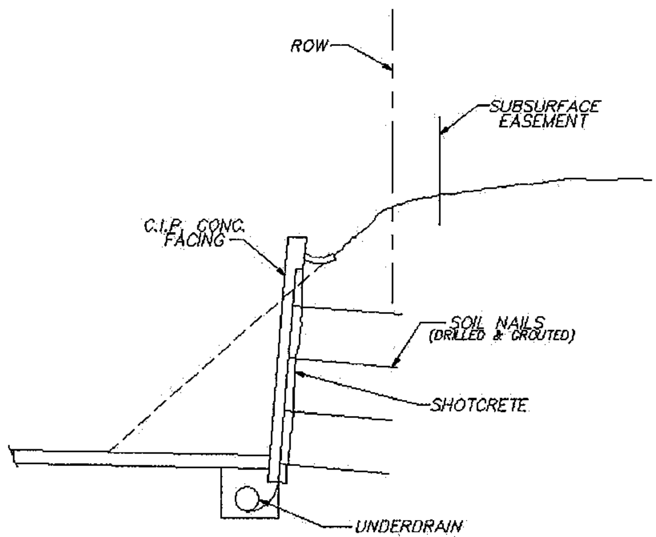
Figure 20

9.2.2 Soil Nail Walls

Soil nail walls are the most cost-effective type of cut wall. (See Figure 21.) They can only be installed in soils that have a standup time of 1 to 2 days for a 4- to 6-foot-tall excavation. The construction sequence is as follows:

1. Initially excavate to 4- to 6-foot depth
2. Drill a row of holes, install and grout soil nails into place
3. Place a drainage material and reinforcing wire mesh, and apply a layer of shotcrete
4. Repeat above steps with next layer of excavation
5. When excavation is complete, cast reinforced cast-in-place wall facing

This wall type utilizes the native soil to anchor the wall and its facing. Permanent subsurface easements are required if the soil nails extend into adjacent properties.



SOIL NAIL WALL
NOT POSSIBLE IN COHESIONLESS SOIL

RETAINING WALLS IN CUT

Figure 21

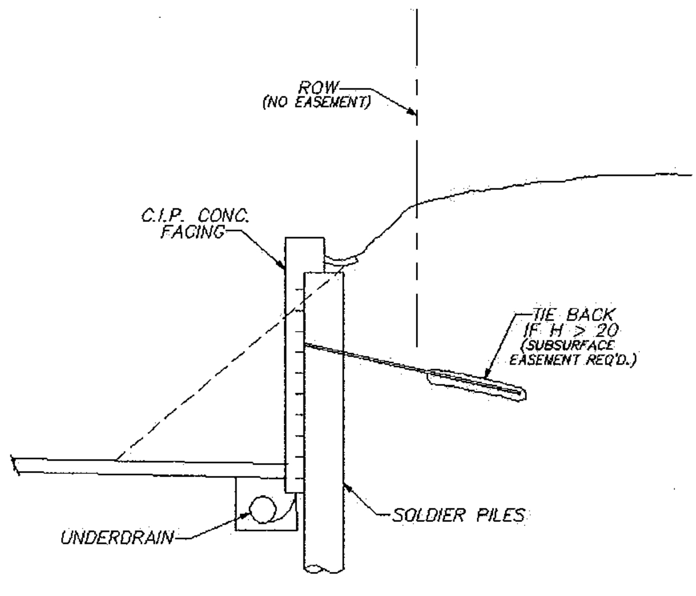
9.2.3 Soldier Pile Walls

Soldier piles with temporary lagging and a final cast-in-place facing allow construction of a cut wall where soils may not be adequate for soil nail wall construction. Because it has a very narrow footprint, this wall type may also be used when traffic runs close to the top of the wall and in restricted locations. (See Figure 22.) This type of wall construction proceeds as follows:

1. Install a row of steel piles (H or W shapes) by driving or embedding them in concrete into drilled holes at a spacing of 6 to 8 feet.
2. As the excavation proceeds down the face of the steel piles; install the lagging. The lagging usually consists of 4-inch-thick timber planks inserted behind the flanges of the piles, to retain the fill.
3. After excavation is complete, drainage material is installed and a reinforced cast-in-place concrete facing is placed to complete the wall.

If needed, traffic barriers can be incorporated into the top of the wall. To avoid future backfill settlements, the lagging may be treated before installation.

If the wall is very high, it may be necessary to use tiebacks to limit the size of the soldier piles. Soldier pile walls are more expensive than soil nail walls.



SOLDIER PILE WALL

RETAINING WALLS IN CUT

Figure 22

9.2.4 Cylinder Pile Walls

In the most severe conditions, cylinder pile walls may be a good choice, although they are very expensive to construct. During the original construction of I-5, some uphill slope movement made it necessary to install cylinder pile walls. Similarly, there were slope stability problems on the south side of SR-520 just east of I-5. In these areas and other high-risk locations, soldier pile walls may be the appropriate solution. Where the wall height is more than 20 feet, it may be cost-effective to install tiebacks and thereby reduce wall size. Site-specific geotechnical investigations will be required before constructing any of these walls. The construction of a cylinder pile wall proceeds as follows:

1. Drill the hole for the pile
2. Install reinforcing cage or welded steel girder
3. Cast concrete to complete one pile
4. Repeat to construct row of piles with small spacing between piles
5. Excavate in front of wall and install tiebacks
6. Install drains and place wall reinforcing
7. Install cast-in-place concrete facing

9.3 TEMPORARY RETAINING WALLS

Temporary retaining walls would be required to facilitate traffic maintenance in areas where the alignment grade is different from the current grade or in locations where temporary lanes have to be constructed into or above existing side slopes. Although all the permanent wall types would work for this purpose, there are several methods that would result in less costly solutions. For low walls, protection of either a fill or a cut can be accomplished by placing concrete (ecology) blocks. For wall heights of more than a few feet, the walls described below would most likely be used.

9.3.1 Temporary Cut Walls

Temporary cut walls can be constructed as soil nail walls. The concrete wall facing used for permanent walls can be omitted, resulting in significant cost savings. Although this is a very cost-effective construction solution, the later excavation of the retained fill would be complicated by the presence of the soil nails.

Because they have a very narrow footprint, soldier pile and lagging wall construction may be utilized in more restricted locations. For temporary walls, the cast-in-place concrete facing can be omitted. The piles and lagging may be salvaged in most cases.

9.3.2 Temporary Fill Walls

The most cost-effective wall for temporary fill conditions is the geosynthetic wall, which functions much like an MSE wall, except the reinforcing consists of geotextile mats that replace the metal anchor strips and concrete facing. If fill is later placed in the adjacent area, the geosynthetic walls are simply left in place.

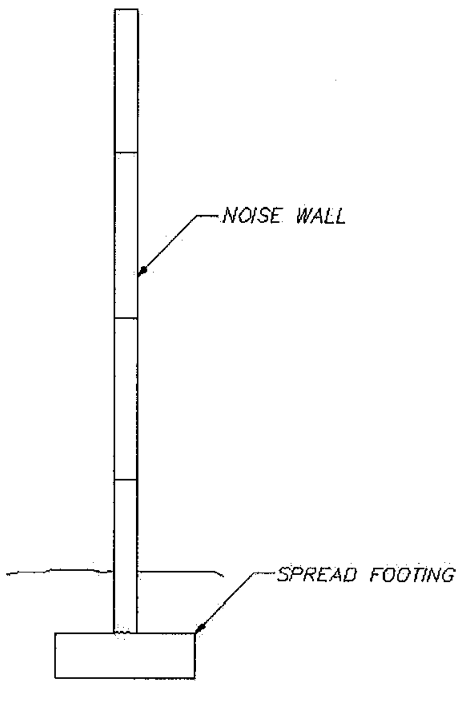
9.4 TIEBACK ON EXISTING WALLS

A segment of the proposed I-5 northbound on-ramp from the Mercer Corridor requires a cut tunnel section along an existing major cylinder pile wall at approximately I-5 MR Line station 60+00 to 65+00. To maintain the integrity of this wall and hillside stability, the tieback anchors must be installed prior to excavation. A technical memorandum *Final Geotechnical Review and Recommendation* (April 11, 2002) indicates that tiebacks to the existing cylinder wall are potentially feasible based on conceptual investigation. However, these slopes were shown to be slide-prone during the original construction of I-5, so it would be necessary to perform detailed geotechnical studies for this area to verify constructability. The forces and tieback length are expected to be substantial, and subsurface easements would be required to allow their construction.

10 NOISE WALLS

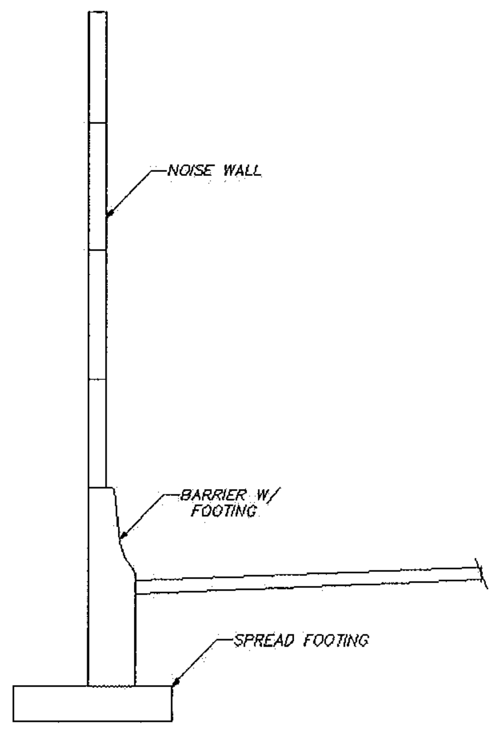
Throughout the corridor, there are numerous locations where noise walls would be located.

The following drawings present a few potential noise wall configuration types. (See Figures 23 and 24.) The noise walls are an important aesthetic element; the wall type and the surface treatment facing the roadway and the adjacent neighborhood need to be considered in the aesthetics study (see section 3.3). In later stages of project development, a noise wall type would be chosen and adapted to meet specific project needs. More noise wall standards can be found in WSDOT's standard plans. When a noise barrier is required on top of the MSE walls, the wall panel is not strong enough to resist the wind load on the noise wall. Therefore, the noise wall must have its own shallow footing on top of the backfill. (See Figure 25.)



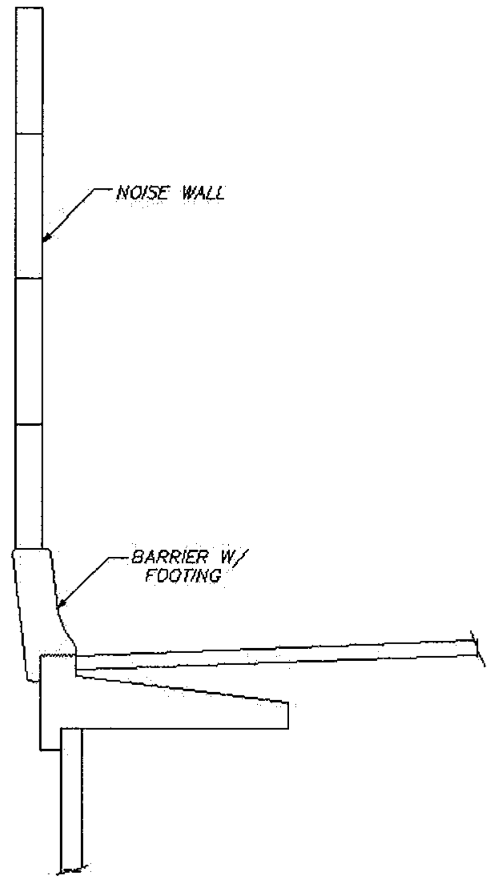
NOISE BARRIER ON SPREAD FOOTING

Figure 23



NOISE BARRIER WITH TRAFFIC BARRIER ON SPREAD FOOTING

Figure 24



NOISE BARRIER WITH
TRAFFIC BARRIER ON RETAINING WALL

Figure 25

11 CONSTRUCTION IN SENSITIVE AREAS

11.1 WETLANDS AND SHALLOW WATER

Bridge construction in wetland areas and in water has a large environmental impact. Wetlands cannot sustain the heavy loads of construction equipment, and are easily damaged by construction activities. There are several wetland areas in the Project area; the most significant one is along SR-520 adjacent to the Arboretum. During construction of the existing SR-520 Bridge, extensive dredging was done to make the site accessible for barges. Construction from barges would be very desirable for this Project, because barges can handle heavy loads and can be maneuvered into the required location. However, because of environmental concerns associated with dredging, this construction method may not be feasible.

The most likely alternative would be to build a construction access trestle parallel to the proposed new bridge. These construction trestles usually consist of driven steel piles that support the steel girder and timber plank decking. Construction and removal could be accomplished from the trestle itself. Because the crane must reach out to the next pier to drive the piles, the support spacing is limited to 20 to 30 feet. At the bridge pier locations, there would be lateral extensions to the trestle to provide access for the heavy equipment needed for installing pilings or shafts.

If driven piles with a concrete cap are installed, a sheet pile cofferdam would have to be constructed to allow dewatering and construction of the pile cap in the dry. This foundation type would only be recommended if the detailed geotechnical investigation shows that shaft foundations are risky or not feasible.

Because the casing encloses the excavation, shaft foundations are the preferred foundation type. The casing can be dewatered or the concrete can be placed under water through a tremie pipe. It is expected that most, if not all, of the pier columns in wetland or shallow water would be founded on shafts.

The superstructure elements, such as precast concrete or steel girders, would be transported over and erected from the construction trestle.

11.2 CONSTRUCTION OVER WATER

Where the water is deep enough (approximately 8 feet or more), construction would be accomplished from barges. Barges would have to be anchored in place to maintain accurate locations for pile driving or shaft installation.

Shaft foundations are the most likely type of foundation in water. Pile foundations would only be used if boulders or other obstructions make shaft installation very risky. In deep water, piles would be driven from the surface and the pile cap installed just at the water level, as described in section 7.2.2.

Construction of a tunnel under the Ship Canal is described in Section 8.2.

11.3 NOISE SENSITIVE AREAS

Residential areas require special consideration during construction. Structurally, the biggest influence on noise impacts is selection of the foundation type. Pile driving can usually be avoided by using shaft foundations, because shafts are drilled rather than driven and are less noisy. However, very heavy equipment is still required.

If pile driving and/or sheet piling cannot be avoided, local noise ordinances would limit construction to daytime.

Erecting bridge girders over traveled lanes is usually limited to nighttime, when the lanes can be closed to traffic. This is expected to occur primarily in the interchange areas. Since these interchange areas have significant traffic, even at night, construction noise from delivery trucks and lifting cranes should not be significantly higher than the background noise. If nighttime erection is not acceptable, daytime closures during weekends may need to be considered.

11.4 DEMOLITION OF EXISTING STRUCTURES

The means and methods of removing existing structures are left to the contractor's discretion. If no restrictions are specified, concrete removal is generally accomplished with pneumatic drills and jackhammers. These rather noisy methods may not be acceptable in all Project locations.

Hydro demolition is a method that utilizes high-pressure water jets to cut through concrete or steel. This method results in quieter operations but would be specified in sensitive areas only, because it is more expensive than the traditional methods described above.

APPENDIX: STRUCTURE LIST

This Appendix provides the following information:

1. Available information on existing structures that may be modified as part of this Project. (Additional information will be collected during further study as this Project continues to move forward.)

2. Proposed new structures, including modifications to existing structures. The information provided is based on conceptual study and may be further refined in the future. The proposed structures are the most likely structural types identified at this time.

The abbreviations listed below are used in the following chart:

BR	Bridge
CBOX	Concrete Box Girder
CCULV	Concrete Culvert
CS	Concrete Slab
CTB	Concrete T-Beam
LID	Lid
OC	Overcrossing
O-XING	Overcrossing
PCB	Pre-Tensioned Concrete Beam
PED	Pedestrian
POB	Post-Tensioned Concrete Beam
POBX	Post-Tensioned Box Girder
PCS	Pre-Tensioned Concrete Slab
SBOX	Steel Box Girder
SG	Steel Girder
TUN	Tunnel
UC	Undercrossing
U-XING	Undercrossing
V	Viaduct

Structure List

				Structure Status			As-Built Structure Information					Proposed Structures			
Structure No.	Location	Line	Type	4-lanes	6-lanes	8-lanes	Min Vert Clear.	Length	Year Built	Superstr. Type	No of Spans	Approx. Max Length	Structure Type	Max Struct Depth	Footing Type
I-5 Mainline															
5/562E	NB Lanes Viaduct	MN	V	Remain	Widen	Widen	NA	381	1961	CTB	11	Match Exist	PCbox	8	Pile / Shaft
5/566W	Denny Way- Lakeview Viaduct	MN	V	Remain	Widen	Widen		7077	1960	Cbox/PCB		Match Exist	PCbox/PCB	Match Exist	Pile / Shaft
5/566E	Galer-Lakeview Viaduct	MS	V	Remain	Widen	Widen		1671	1960	PCB		Match Exist	PCB	Match Exist	Pile / Shaft
5/570	Ship Canal Bridge	MS	BR	Remain	Widen	Widen		4429		ST Cbox CS		Match Exist	Cbox	Match Exist	Pile/Shaft
I-5 Ramp & U-Xing															
New	Mercer St to I-5 NB	XN	TUN	No	New	New						900	Tunnel	NA	NA
5/555S-W	S-Stewart Ramp BR	SX	BR	Remain	Remove/New	Remove/New		213		CBox		500	PCBox/PCB	7	Pile / Shaft
5/564	Lakeview Blvd. UC	LX	U-XING	Remain	Replace	Replace	20	1215	1961	CBox	15	1215	PCBox/Sbox	11	Pile / Shaft
5/566N-E	N-Harvard Ramp BR		Ramp	Remain	Remove	Remove		181		PCB		NA	NA	NA	NA
5/566E-S	Newton-S Ramp BR		Ramp	Remain	Remove	Remove		619		PCB		NA	NA	NA	NA
New	SB to Mercer St	SW	Ramp	No	New	New	NA	NA	NA	NA	NA	500	PCbox/PCB	7	Pile / Shaft
New	NB to Lakeview	NX	Ramp	No	New	New	NA	NA	NA	NA	NA	2100	PCbox/PCB	7	Pile / Shaft
New	Boylston to SB	SS	Ramp	No	New	New						1050	PCbox/PCB	7	Pile / Shaft
520/1W-S	W-S Ramp UC	HNE	U-XING	Replace	Replace	Replace	15	351		CBox	3	420	PCBox/Sbox	10	Pile / Shaft
New	W-S Ramp UC	WS	U-XING	No	New	New	NA	NA	NA	NA	NA	600	PCBox/Sbox	10	Pile / Shaft
5/569	Roanoke St UC	CX	U-XING	Remain	Replace	Replace	15	267	1961	CBox	3	300	PCbox	7.5	Pile / Shaft
5/568S-E	S-E Ramp Tunnel	HSE	TUN	Remain	Remain	Remain	14	662	1960	CTUN		NA	NA	NA	NA
New	I-5 SB to SR520 EB Tunnel	SE	TUN	No	New	New	NA	NA	NA	NA	NA	1500	TUN	NA	NA
New	Lid at I-5 to SR 520 Interchange Area		LID	No	New	New	NA	NA	NA	NA	NA	NA	PCB	9	Pile/Shaft
SR 520 U-Xing, O-Xing and Ramp															
520/1	10th Ave UC	AX	U-XING	Replace	Replace	Replace	16.5	285	1961	CBox	3	380	PCB	8	Pile/Shaft
520/2	Delmar Drive UC	BX	U-XING	Replace	Replace	Replace	16	154	1961	CBox	2	300	PCB	8	Pile/Shaft
520/3	Portage Bay	ML,MR	BR	Replace	Replace	Replace	N/A	2840	1961	PCB	29	Match Exist	PCB	16 at pier, 6 mid	Pile/Shaft
	Montlake														
New	SR 520 EB to Montlake	DES	Ramp	New	New	New	NA	NA	NA	NA	NA	800	PCbox/PCB	8	Pile/Shaft
New	Montlake to SR 520 WB	DSW	Ramp	No	New	New	NA	NA	NA	NA	NA	700	PCbox/PCB	8	Pile/Shaft
520/3E-N	E Montlake Ramp		BR	Remove	Remove	Remove	N/A	375	1961	PCB	5	NA	NA	NA	NA
513/10	SR 520 UC Montlake Blvd	DX	U-XING	Replace	Replace	Replace	15	152		CBox		290	PCBox/PCB	7	Pile/Shaft
New	Lid SR 520 - Montlake Blvd Interchange		LID	No	New	New	NA	NA	NA	NA	NA	NA	PCB	9	Pile/Shaft
520/6N-N	N-Montlake Ramp UC		Ramp/UC	Remove	Remove	Remove	15	1423	1961	SB PCB CS	18	NA	NA	NA	NA
520/6W-S	W-S Ramp UC		Ramp/UC	Remove	Remove	Remove	17.04	1752	1961	PCB	19	NA	NA	NA	NA
520/6A	Arboretum & N. Montlake OC		O-XING	Remove	Remove	Remove		385		PCB		NA	NA	NA	NA
520/6N-E	N-E Ramp BR		Ramp	Remove	Remove	Remove		1461		PCB		NA	NA	NA	NA
520/6W-S	W-S Ramp BR SR 520 OC		O-XING	Remove	Remove	Remove		1752		PCB		NA	NA	NA	NA
520/6B	Arboretum & N. Montlake OC		O-XING	Remove	Remove	Remove		366		PCB		NA	NA	NA	NA
520/6W-W	W-Montlake Ramp BR		Ramp	Remove	Remove	Remove	N/A	1001	1961	PCB	10	NA	NA	NA	NA
520/6W-S	W-Montlake Ramp, W-S Ramp UC		U-XING	Remove	Remove	Remove	14	1752	1961	PCB	19	NA	NA	NA	NA
520/5	W-Montlake Ramp, 24th Ave UC		U-XING	Remove	Remove	Remove	15	169		CBox		NA	NA	NA	NA
New	Pacific St Tunnel (or Montlake Tunnel)	EPX	TUN	No	No	New	NA	NA	NA	NA	NA	2000	TUN	NA	NA
New	Pacific St to EB Tunnel	EPE	TUN	No	No	New	NA	NA	NA	NA	NA	1500	TUN	NA	NA
New	Tunnel to WB Pacific St.	EPW	TUN	No	No	New	NA	NA	NA	NA	NA	600	TUN	NA	NA
New	Montlake SB to Tunnel	EMP	TUN	No	No	New	NA	NA	NA	NA	NA	1000	TUN	NA	NA
New	Tunnel to Montlake NB	EPM	TUN	No	No	New	NA	NA	NA	NA	NA	500	TUN	NA	NA
New	Semi-underground Montlake Blvd and Pacific Ave. Interchange						NA	NA	NA	NA	NA	NA	PCBox/PCB	7	Pile/Shaft
New	Bike/Ped Bridge on Montlake Blvd 61+00		PED BR	No	New	New	NA	NA	NA	NA	NA	180	PCBox/PCB	6	Pile/Shaft
New	Bike/Ped Bridge on Montlake Blvd 73+00		PED BR	No	New	New	NA	NA	NA	NA	NA	180	PCBox/PCB	6	Pile/Shaft
New	Bike/Ped Bridge on Montlake Blvd 80+00		PED BR	No	New	New	NA	NA	NA	NA	NA	180	PCBox/PCB	6	Pile/Shaft
	Lake Washington Crossing														
520/6	Union Bay, ESE, EWN, HSE, HWN Lines		BR	Replace	Replace	Replace	N/A	1902	1961	SB PCB CS	19	See Separate Rport From WSDOT Bridge and Structures Office			
520/8	Albert D. Rosellini BR		BR	Replace	Replace	Replace	15	12404		CFP ST SB PCB		See Separate Rport From WSDOT Bridge and Structures Office			

Structure List

				Structure Status			As-Built Structure Information					Proposed Structures			
Structure No.	Location	Line	Type	4-lanes	6-lanes	8-lanes	Min Vert Clear.	Length	Year Built	Superstr. Type	No of Spans	Approx. Max Length	Structure Type	Max Struct Depth	Footing Type
	Points Community														
520/9	Evergreen Point Rd / 76th Ave. NE		U-XING	Replace	Replace	Replace	16	93	1961	PCB	1	240	PCB	6	Pile/Shaft
New	Lid SR 520 76th Ave UC with BRT Stop		LID	No	New	New	NA	NA	NA	NA	NA	240	PCB	9	Pile/Shaft
520/10P	Ped bridge (adjacent to 80th Ave NE)		U-XING	Replace	Replace	Replace	16.5	275	1961	CS	5	240	PCB	7	Pile/Shaft
520/11	84th Ave NE UC	BB	U-XING	Replace	Replace	Replace	17.23	93	1961	PCB	1	250	PCB	7	Pile/Shaft
New	Lid SR 520 84th Ave UC		LID	No	New	New	NA	NA	NA	NA	NA	250	PCB	9	Pile/Shaft
520/12	92nd Ave NE UC	CC	U-XING	Replace	Replace	Replace	16.71	97	1961	PCB	1	250	PCB	6	Pile/Shaft
New	Lid SR 520 92nd Ave UC with BRT Stop		LID	No	New	New	NA	NA	NA	NA	NA	250	PCB	9	Pile/Shaft
	Bellevue Way														
New	Bellevue Way to WB	XW	Ramp	No	New	New	NA	NA	NA	NA	NA	1350	Cbox/PCB	8	Pile/Shaft
New	EB to Bellevue Way	EX	U-XING	No	New	New	NA	NA	NA	NA	NA	300	Sbox/SG/PCB	7	Pile/Shaft
520/14	Bellevue Way NE / 104th Ave NE UC	EE	U-XING	remain	Remove/New	Remove/New	16.16	116	?	CBox	1	210	Sbox/SG/PCB	7	Pile/Shaft
New	WB to Bellevue Way	WX	U-XING	No	New	New	NA	NA	NA	NA	NA	2370	Sbox/PCbox/PCB	12	Pile/Shaft
New	Bellevue Way to EB	XE	Ramp	No	New	New	NA	NA	NA	NA	NA	450	PCbox/PCB	7	Pile/Shaft
520/16	SR 520 EB, 108th Ave NE, OC	MR	O-XING	remain	Remove/New	Remove/New	17	271	1965	CBox	3	280	PCB	6	Pile/Shaft
New	SR 520 WB, 108th Ave NE, OC	ML	O-XING	No	New	New	NA	NA	NA	NA	NA	290	PCB	6	Pile/Shaft
New	108th Ave, on-ramp	NW	Ramp	No	New	New	NA	NA	NA	NA	NA	250	PCB	6	Pile/Shaft
	I-405 Interchange														
405/46N-W	N-W Ramp UC		U-XING	remain	Remove	Remove	16	260	1964	CS	4	NA	NA	NA	NA
405/47S-E	S-E Ramp UC		U-XING	remain	Remove	Remove	24	720	1990	PCB	8	NA	NA	NA	NA
405/46W	I-405 SB		U-XING	remain	Remove	Remove	16.68	241	1964	PCB	4	NA	NA	NA	NA
405/46E	I-405 NB		U-XING	remain	Remove	Remove	16.88	247	1964	PCB	4	NA	NA	NA	NA
New	NB to WB, Bridge 1	NW	Ramp	No	New	New	NA	NA	NA	NA	NA	1100	Sbox/PCBox	8	Pile/Shaft
New	NB to WB, Bridge 2	NW	Ramp	No	New	New	NA	NA	NA	NA	NA	700	Sbox/PCBox	10.5	Pile/Shaft
New	SB to WB	SW	Ramp	No	New	New	NA	NA	NA	NA	NA	3350	Sbox/PCBox	12	Pile/Shaft
New	HOV EB to NB	HEN	Ramp	No	New	New	NA	NA	NA	NA	NA	2200	Sbox/PCBox	12	Pile/Shaft
New	HOV EB to SB	HES	Ramp	No	New	New	NA	NA	NA	NA	NA	1500	Sbox/PCBox	12	Pile/Shaft
New	HOV NB to EB	HNE	Ramp	No	New	New	NA	NA	NA	NA	NA	3200	Sbox/PCBox	11	Pile/Shaft
New	HOV NB to WB	HNW	Ramp	No	New	New	NA	NA	NA	NA	NA	250	PCB	5	Pile/Shaft
New	EB to NB, EN Line	EN	Ramp	No	New	New	NA	NA	NA	NA	NA	3000	Sbox/PCBox	9.5	Pile/Shaft
New	EB to SB, ES Line	ES	Ramp	No	New	New	NA	NA	NA	NA	NA	2000	Sbox/PCBox	8.5	Pile/Shaft
New	SB to EB, Bridge 1	SE	Ramp	No	New	New	NA	NA	NA	NA	NA	1500	Sbox/PCBox	9	Pile/Shaft
New	SB to EB, Bridge 2	SE	Ramp	No	New	New	NA	NA	NA	NA	NA	1000	Sbox/PCBox	9	Pile/Shaft
New	NB to EB, Bridge 1	NE	Ramp	No	New	New	NA	NA	NA	NA	NA	1700	Sbox/PCBox	10	Pile/Shaft
New	NB to EB, Bridge 2	NE	Ramp	No	New	New	NA	NA	NA	NA	NA	1400	PCBox/PCB	9	Pile/Shaft
New	WB to SB	WS	Ramp	No	New	New	NA	NA	NA	NA	NA	5000	Sbox/PCBox	10.5	Pile/Shaft
New	WB to NB	WN	Ramp	No	New	New	NA	NA	NA	NA	NA	2300	Sbox/PCBox	10.5	Pile/Shaft
New	I-405 SB to NE 8th St, Bridge 1	SX	Ramp	No	New	New	NA	NA	NA	NA	NA	750	PCBox/PCB	8	Pile/Shaft
New	I-405 SB to NE 8th St, Bridge 2	SX	Ramp	No	New	New	NA	NA	NA	NA	NA	2250	PCBox/PCB	8	Pile/Shaft
New	Northup Way to SB, Bridge 1	PXS	Ramp	No	New	New	NA	NA	NA	NA	NA	400	PCBox/PCB	9	Pile/Shaft
New	Northup Way to SB, Bridge 2	PXS	Ramp	No	New	New	NA	NA	NA	NA	NA	300	PCBox/PCB	9	Pile/Shaft
New	SB to Northup Way	PSX	Ramp	No	New	New	NA	NA	NA	NA	NA	400	PCBox/PCB	7	Pile/Shaft
New	NB to Northup Way	PNX	Ramp	No	New	New	NA	NA	NA	NA	NA	400	PCBox/PCB	7	Pile/Shaft
New	Bellevue NB CD to NB 405	XN	Ramp	No	New	New	NA	NA	NA	NA	NA	1000	PCBox/PCB	10	Pile/Shaft
New	SR 520 ML 406+00 to 422+00	ML	O-XING	No	New	New	NA	NA	NA	NA	NA	1600	PCBox/PCB	10	Pile/Shaft
New	SR 520 MR 402+00 to 424+00	MR	O-XING	No	New	New	NA	NA	NA	NA	NA	2200	PCBox/PCB	10	Pile/Shaft
520/18E-N	E-N Ramp UC, I-405 UC		U-XING	remain	Remove	Remove	19.75	1112	1992	SG	7	NA	NA	NA	NA
520-21	116th Ave NE		O-XING	remain	Remove	Remove	15	165	1965	PCB	3	NA	NA	NA	NA
520/19E-N	E-N Ramp, Northup Way OC		O-XING	remain	Remove	Remove	14.6	162	1991	PCB	3	NA	NA	NA	NA
520/20E-N	E-N Ramp, BNRR OC		O-XING	remain	Remove	Remove	20	320	1991	PCB	4	NA	NA	NA	NA
520/19W-N	W-N Ramp, Northup Way OC		O-XING	remain	Remove	Remove	14.6	162	1991	PCB	3	NA	NA	NA	NA
520/22S	BNRR OC		O-XING	remain	Remove	Remove	22.5	208	1991	PCB	3	NA	NA	NA	NA

Structure List

				Structure Status			As-Built Structure Information					Proposed Structures			
Structure No.	Location	Line	Type	4-lanes	6-lanes	8-lanes	Min Vert Clear.	Length	Year Built	Superstr. Type	No of Spans	Approx. Max Length	Structure Type	Max Struct Depth	Footing Type
520/22N	BN RR OC (NP)		O-XING	remain	Remove	Remove	22.5	199	1991	PCB	3	NA	NA	NA	NA
520/22.5S	Half Bridge		BR	remain	Remove	Remove		193		PCB		NA	NA	NA	NA
520/25N	Northup Way OC		O-XING	remain	Remove	Remove		376		CBox		NA	NA	NA	NA
520/25S	Northup Way OC		O-XING	remain	Remove	Remove		392		CBox		NA	NA	NA	NA
	O-Xing & U-Xing														
520/27N	124th N-W Ramp OC	ML	O-XING	remain	Replace	Replace	16	255		PCB		320	PCB	7	Pile/Shaft
New	124th N-W Ramp OC	HWS	O-XING	No	New	New	NA	NA	NA	NA	NA	240	PCB	7	Pile/Shaft
520/27S	124th N-W Ramp OC	MR	O-XING	remain	Replace	Replace	16	200		PCB		240	PCB	7	Pile/Shaft
520/30N	130th Ave NE OC	ML	O-XING	remain	Widen	Widen	15.3	210	1969	PCB	3	Match Exist	PCB	Match Exist	Pile/Shaft
520/30S	130th Ave NE OC	MR	O-XING	remain	Widen	Widen	21.8	210	1969	PCB	3	Match Exist	PCB	Match Exist	Pile/Shaft
520/30BP	130 th Ave NE OC		O-XING	remain	Remain	Remain		216		PCB		NA	NA	NA	NA
520/32	140th Ave NE OC	ML, MR	O-XING	remain	Widen	Widen	15.2	213	1971	PCB	1	Match Exist	PCB	Match Exist	Pile/Shaft
520/34S	NE 24th St OC	MR	O-XING	remain	Widen	Widen	16.22	329	1971	PCB	3	Match Exist	PCB	Match Exist	Pile/Shaft
520/34N	NE 24th St OC	ML	O-XING	remain	Widen	Widen		330		PCB	3	Match Exist	PCB	Match Exist	Pile/Shaft
520/34BP	NE 24th St OC BP		O-XING	remain	remain	remain		330		PCB	3	NA	NA	NA	NA
520/36	148th Ave NE	QQ	U-XING	remain	remain	remain	18.7	325	1979	POBX	2	NA	NA	NA	NA
52037	NE 40th St	SS	U-XING	remain	remain	remain	17	219	1978	PCB	2	NA	NA	NA	NA
	NE 51st Street														
520/38	NE 51st St	TT	U-XING	remain	remain	remain	18.83	228		PCB	2	NA	NA	NA	NA
New	51st to WB, UWX Crossing	VXW	Ramp	No	New	New	NA	NA	NA	NA	NA	110	PCB/PCS	5	Pile/Shaft
New	51st to WB, Ped. Crossing	VXW	Ramp	No	New	New	NA	NA	NA	NA	NA	20	PCS/CCULV	3	Pile/Shaft
New	WB to 51st, Ped. Crossing	VWX	Ramp	No	New	New	NA	NA	NA	NA	NA	20	PCS/CCULV	3	Pile/Shaft
New	EB to 51st, UXE Crossing	VEX	Ramp	No	New	New	NA	NA	NA	NA	NA	200	PCB/PCS	6	Pile/Shaft
	NE 60th Street														
520/39	NE 60th St		U-XING	remain	remain	remain	16.5	254	1978	PCB	2	NA	NA	NA	NA
520/39p	NE 60th St. Equestrian bridge		U-XING	remain	remain	remain	16.02	253	1978	CG	2	NA	NA	NA	NA
	W Lake Sammamish Parkway														
520/42S	W Lake Sammamish PKWY OC	MR	O-XING	remain	Widen	Widen	18.8	387	1976	CBox	4	Match Exist	POBX	Match Exist	Pile/Shaft
520/42N	W Lake Sammamish PKWY OC	ML	O-XING	remain	Widen	Widen		392		POBX	4	Match Exist	POBX	Match Exist	Pile/Shaft
New	Ramp From SR520 W to Samm. PKWY	WX	O-XING	No	New	New	NA	NA	NA	NA	NA	500	POBX	Match Exist	Pile/Shaft
New	Ramp From Samm. PKWY to SR 520 E.	XE	O-XING	No	New	New	NA	NA	NA	NA	NA	500	POBX	Match Exist	Pile/Shaft
New	Samm. PKWY to SR 520 WB	XW	Ramp	No	New	New	NA	NA	NA	NA	NA	60	PCB/PCS	5	Pile/Shaft
	Redmond Way SR 202														
520/46	SR 202 & BNRR OC	MR	O-XING	remain	Widen	Widen		463		PCB		Match Exist	PCB	Match Exist	Pile/Shaft
New	SR 202 & BNRR OC	ML	O-XING	No	New	New	NA	NA	NA	NA	NA	500	PCB	7	Pile/Shaft
520/48A	NE 76th Street OC- EB	MR	O-XING	remain	Widen	Widen	16.5	226	1961	PCB	1	Match Exist	PCB	Match Exist	Pile/Shaft
New	NE 76th Street OC- EB	ML	O-XING	No	New	New	NA	NA	NA	NA	NA	250	PCB	7	Pile/Shaft
New	LXW Line Ramp Cross SR 202	LXW	Ramp	No	New	New	NA	NA	NA	NA	NA	1000	PCB	7	Pile/Shaft
New	SR 202 HOV HEW Line	HEW	O-XING	No	New	New	NA	NA	NA	NA	NA	2250	PCB	7	Pile/Shaft
New	T-Connection to HOV HEW Line at Redmond	HNS	Ramp	No	New	New	NA	NA	NA	NA	NA	600	PCB	7	Pile/Shaft
New	HOV On Ramp at Redmond	HZW	Ramp	No	New	New	NA	NA	NA	NA	NA	500	PCBox/PCB	10	Pile/Shaft
New	HOV Off Ramp at Redmond	HEZ	Ramp	No	New	New	NA	NA	NA	NA	NA	600	PCBox/PCB	10	Pile/Shaft